The Welding Engineer

Edited by L. B. Mackenzie

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Announcing the Consolidation of

Air Reduction Sales Company
and
Davis-Bournonville Company

On March 17, 1922, final arrangements were perfected for the amalgamation of Davis-Bournonville Company with Air Reduction Sales Company.

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Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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Air Reduction Sales Co.
Commercial Acetylene Supply Co.
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Carbic Mfg. Co.
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Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
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United States Welding Co.

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Hauck Mfg. Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
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Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.

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Gas Products Association
International Oxygen Co.

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Universal Oxygen Co.

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Hauck Mfg. Co.
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Smith's Inventions, Inc.
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Linde Air Products Co.

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Modern Engineering Co.
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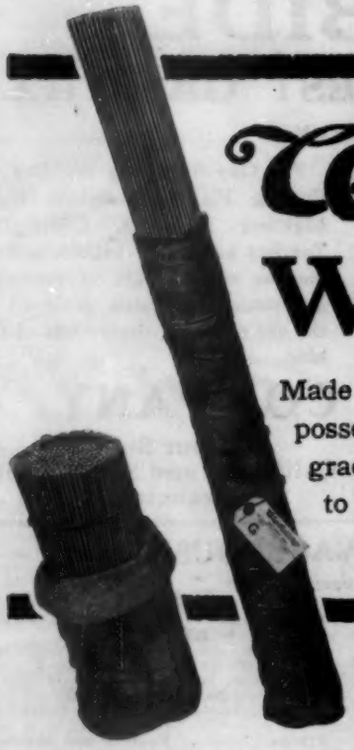

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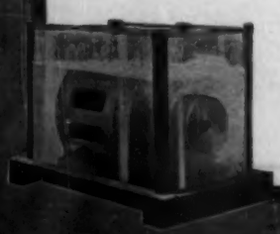

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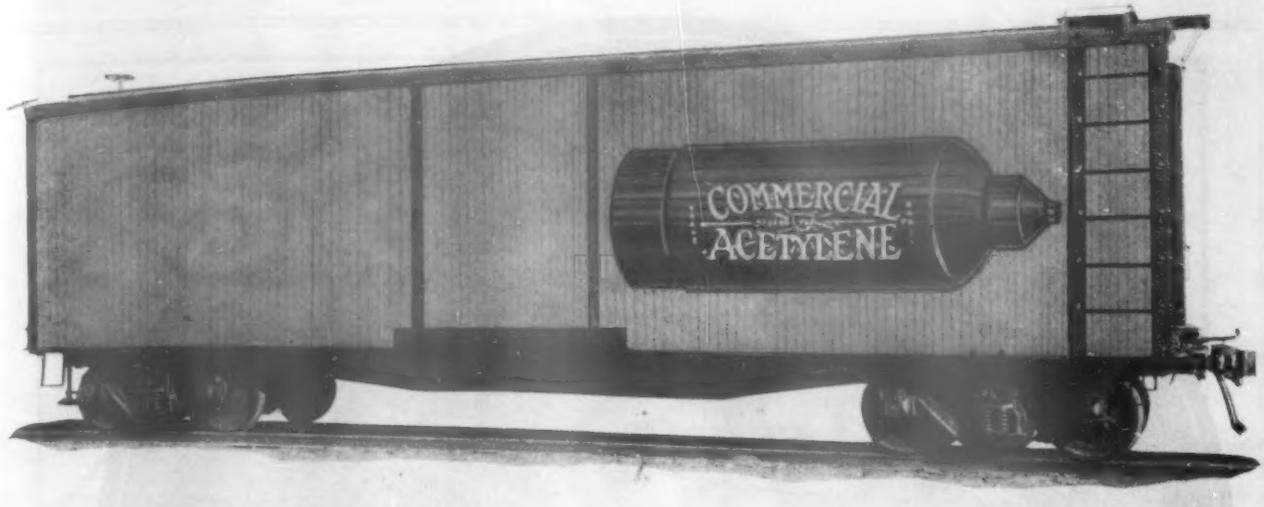

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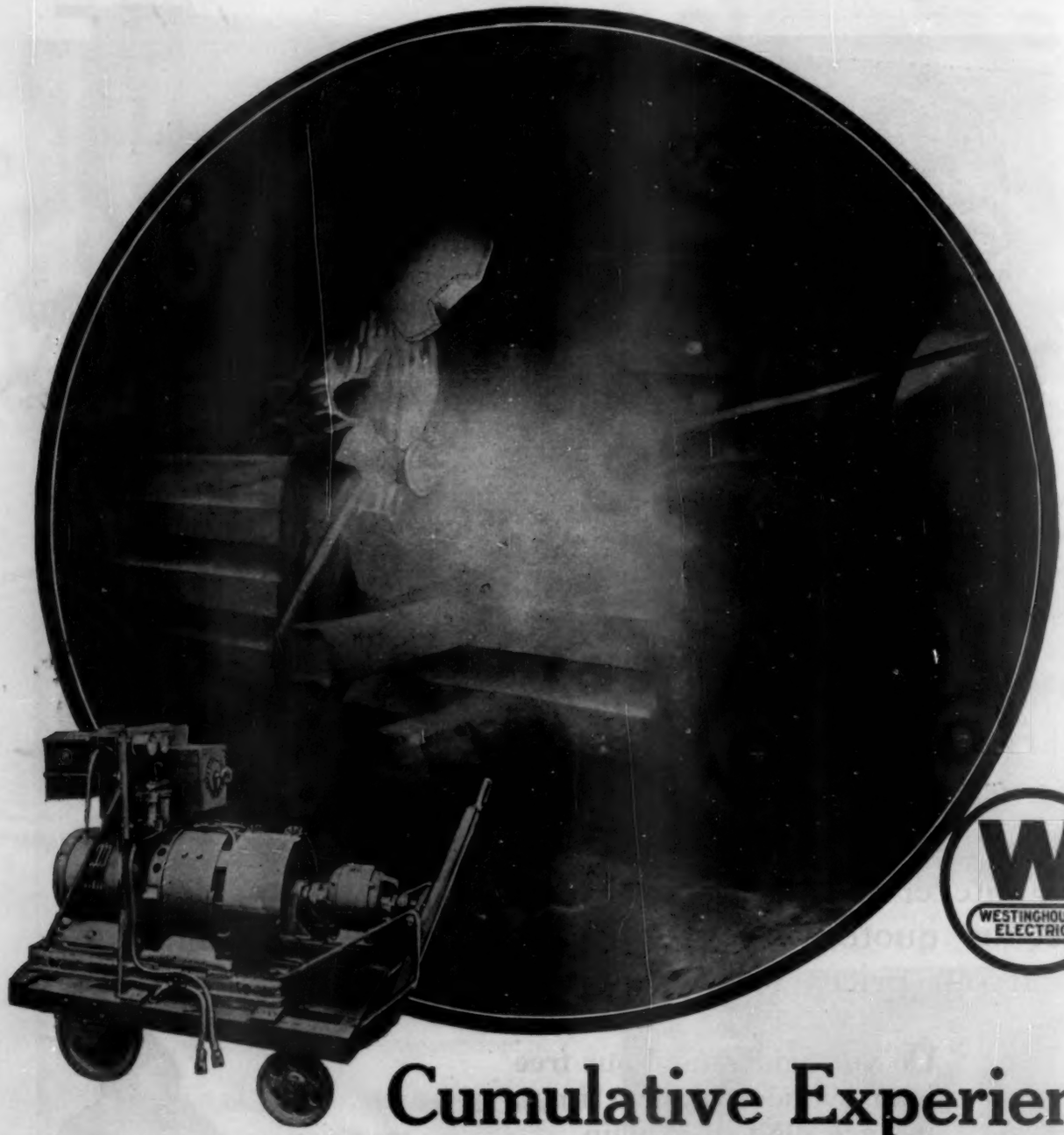

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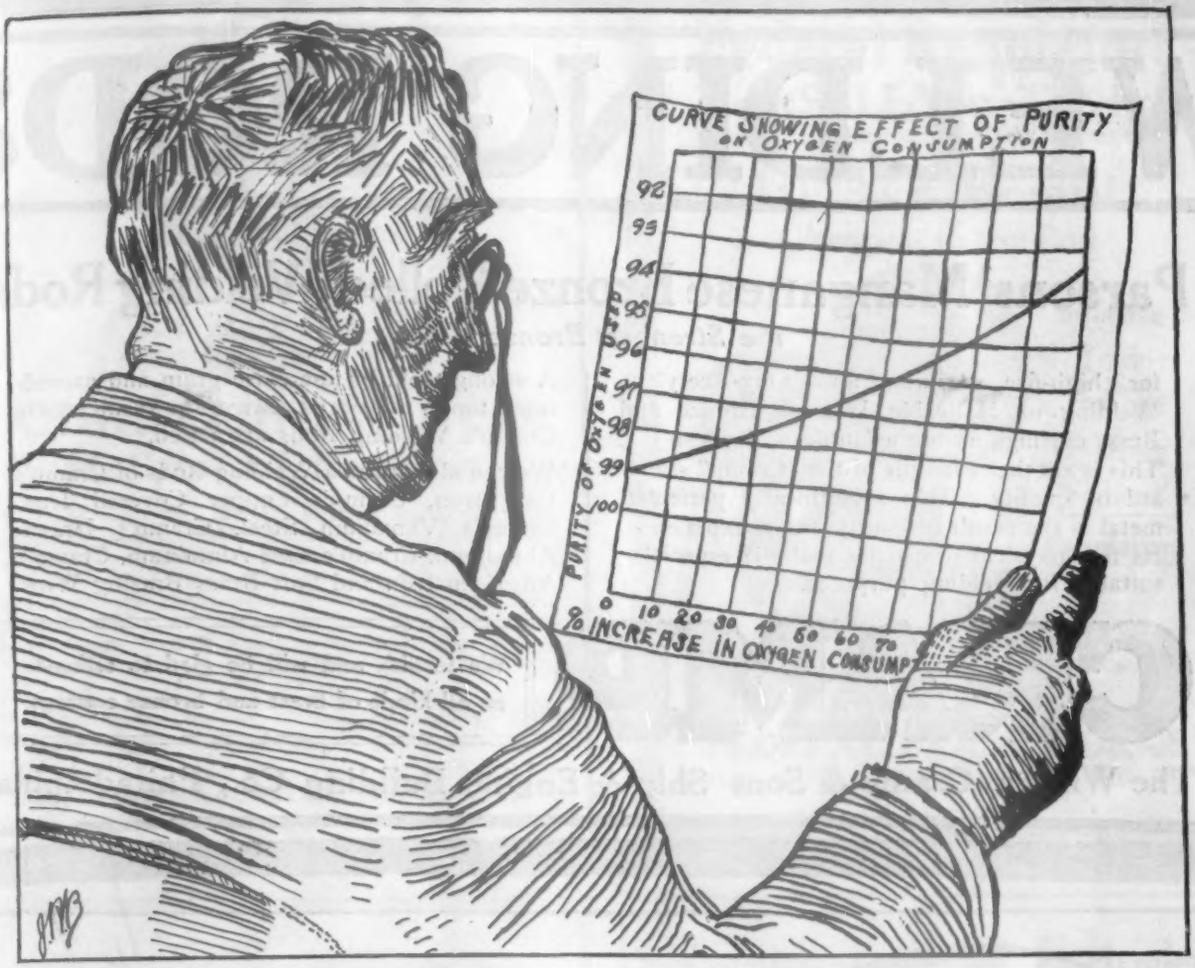

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National Oxygen Co., Chicago
Swift & Co., Chicago

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IOWA
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Kentucky Oxygen-Hydrogen Co., Louisville

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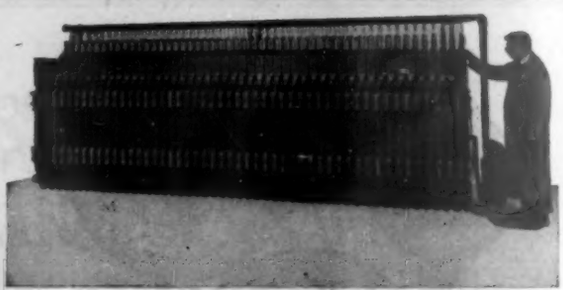

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2012-22

STANDARDS FOR TESTING WELDS

Prominent English Authorities on Welding Discuss the Desirability of Adopting Certain Test Standards

A PAPER entitled, "The Desirability of Standardization in the Testing of Welds," by F. M. Farmer, of New York, was read about a year ago before the Institution of Mechanical Engineers, London, by Mr. William H. Patchell, vice-president of the I. M. E. Mr. Farmer's paper discussed substantially the same test standards as those recently published in the form of a report of the Committee on Testing Welds, of the American Welding Society. There was considerable interesting comment on this paper at a meeting in London, February 18, 1921.

Brig.-General R. K. Bagnall-Wild, C. M. G., C. B. E., said the author was a brave man to tackle the subject of inspection of welds. This had, so far as he was aware, never been thoroughly discussed in England, and he hoped that the discussion would be of value in ventilating the subject. He would confine his remarks to commercial testing only, testing under bulk production, and to the use of welded thin sheet, tubes and metal fittings for aircraft. In reading through the paper he had been struck by the fact that the tests to be imposed were tests of special pieces, in other words, the testing of the ability of the workman who was going to put his very best work into the test-pieces and not the testing of the welds under ordinary commercial production. It might be asked how could that be done, and, as a matter of fact, he was bound to say he did not know. In aircraft work, welds were not used where the part was subject to direct tensile stress or to shear. The only useful method of testing he had discovered was to test the actual part, that was, to select and destroy a certain percentage of finished articles and make a test-piece cut therefrom.

In the material tests he noted the composition was given, and he regarded that as of great importance, but would suggest that the percentage of nickel should be specified in the composition. He had had experience of failure with some sheet steel. It would not weld. It was ordered as an ordinary carbon-steel, but it was found eventually that the scrap used in making that steel contained a percentage of nickel. Nickel had to be down to practically 0 per cent or, at the worst, only a trace. With regard to the mechanical test, he noticed that the author did not say whether his test-piece was tested as cast, that is, as welded, or whether it was subsequently normalized. That was most important, and should be stated in the specification. He himself would prefer it to be normalized.

Then again, the author machined his weld. So far as thin material was concerned, it was quite impossible to get any test result representing the finished article if the skin was machined off. The bending test was a good one and he himself had used it right throughout the war. The stress-reversals test, he suggested, was hardly a commercial one; it was very useful, but he would substitute for it an ordinary impact test in commercial testing. With regard to the author's reference to the angle of the V, that ought to be most carefully considered when tests were being made, and should be recorded every time.

To guarantee safety, so far as possible, the selective scheme was essential, that is, destroying one part in a certain percentage according to the importance of the finished article. A most useful test was to saw the part up longitudinally, etch it with picric or nitric acid, and examine the surface. That was especially necessary, not so much with regard to the material in the weld itself but with regard to what had happened to the material in the neighborhood of the weld.

Mr. R. S. Johnson (Lloyd's Register of Shipping) said that the first case of any repairs to vessels classed with Lloyd's Register being effected by welding occurred in 1906, although the practicability of welding by the electric arc process had been demonstrated many years before that time. The satisfactory nature of these early repair jobs had led to the permanent establishment of the art of welding in the engineering world, and its field of application was rapidly extending with the increase of knowledge and experience of the subject. In 1917 welding was in a suffi;ciently advanced stage to warrant the possibility of its being applied to the structural members of a vessel, and it was realized by Lloyd's Register that more information should be obtained regarding the physical properties of welding and welding material, before the introduction of welding in place of riveted work, in a structure subject to alternating stresses, could be approved. Experiments for the purpose of ascertaining the ultimate strength of welded connections had already been carried out at Washington and by the British Admiralty, with very satisfactory results, but they were quite inadequate so far as a general standardization of welding tests was concerned.

The tests arranged and carried out by Lloyd's Register were very similar to those recommended by Mr. Farmer, and they had been fully described by Sir Westcott Abell, K. B. E., in his papers read before the Institution of Civil Engineers and the North-East Coast Institution of Engineers and Shipbuilders. So far as mechanical tests were concerned, the only practical import they held for the structural engineer was the evidence they gave of the properties possessed by the welded joint when stressed up to the elastic limit, or it would perhaps be more accurate to say, within the working limits of the material used. Ultimate strength was only of value as a rough test, while the measurement of the yield-point and of the total elongation was entirely misleading, because of the fact that the weld formed such a small portion of the length of the specimen over which these items were measured. The ultimate elongation of a welded specimen was considerably less than that of the unwelded plate, and the reason for this was that at high stresses (exceeding the elastic limit) the welded material was much less ductile than ordinary mild steel and broke abruptly, without flow of the metal and without a gradual contraction of area at the point of fracture.

In the experiments carried out by Lloyd's Register, the average ultimate elongation measured over a distance of 8 inches was found in the case of a plain piece to be 29 per cent, for a longitudinal weld 12 per cent, and for a transverse weld 8 per cent. The measurement of the reduction in area at the point of fracture had no practical value, because in most standard systems of welding it was found that the test-piece broke clear of the weld. The author attached considerable importance to the value of the bending test. In the tentative regulations and tests required by Lloyd's Register for the approval of welding systems, no bending test was included, and this was in view of the results obtained from a series of cold-bending experiments. The specimens were 18 inches in length by 3 inches in breadth, and were bent over a block having a diameter equal to three times the thickness of the plate. Tests were made with plates ranging from ¼ inch to 1 inch in thickness and with the apex and the base of the weld arranged alternately uppermost. As was expected there was considerable difference in the angle of bend in the two cases

at which the specimens fractured, depending upon which end of the weld was uppermost. In the ¼ inch and 1 inch plates, the average differences in the angle of bend were found to be 14° and 5° respectively. The best angle of bend at which fracture occurred in the ¼ inch plates was 87° and for the 1 inch plate 23½°, whereas similar test-pieces of plain plate cut from the plates from which the welded samples were made were found in all cases to submit to an angle of bend of 180° without fracture. It would, therefore, be unreasonable to include a bending test in any regulations framed for the purpose of testing the merits of a system of welding. It could also be concluded from the results of these bending tests that the angle at which the V was cut in the original plate, would have considerable effect upon the angle of bend at which fracture would occur.

The author stated that in structures where vibration was always present, fatigue tests were of great importance; especially was this so from a shipbuilder's point of view; but for general purposes, giving due consideration to the experience gained of bending tests, it would be more reasonable under his system of numerical evaluation to assign a value of 2 to the fatigue tests and certainly not more than 1 to a bending test. In such a structure as a ship, it was of extreme importance that welded joints should be able to withstand continued alternating stresses, and a series of rotary tests were for this reason required by the Rules of Lloyd's Register. The tests were similar to those recommended in the paper, but Mr. Farmer's machine appeared to be unnecessarily heavy and complicated. The machine devised by the staff of Lloyd's Register for this purpose was in accordance with the suggestions of Dr. W. Mason, A. M. I. Mech. E., of the University of Liverpool.

A further test, not included in the paper but required by Lloyd's Regulations, was one of impact. It was found that in some early cases of welding when the run was struck by a hammer, pieces of the welding material became loose, and in testing a system it was therefore considered advisable to include some test that would give an indication of the brittleness of the weld. It was found that welded plates could withstand impact with a considerable degree of success; a ½-inch plate arranged on supports 4 feet 6 inches apart and raised 18 inches from the ground sustained two successive blows of 4 cwt. dropped through 12 feet, giving a deflection of 12 inches without any signs of fracture in the weld; and in no case had any failure occurred under this test.

Since the completion of the tests of 1918, the Committee of Lloyd's Register had continued their researches into the question of electric welding and for their information Dr. Marchant, of Liverpool University, had carried out a most exhaustive series of experiments with a view to ascertaining the electrical conditions under which welding should be carried out and, if possible, to determine the electrical properties of the electrode. An automatic welding machine was devised to enable the welding to be carried out in a perfectly definite way to secure comparable results in respect of variations in current and voltage. Various types of electrodes were used, and by means of an oscillograph, photographic records were obtained showing the variation in voltage and amperage during the process of welding. From the results obtained, it would appear that the current and pressure were much steadier when the electrode was positive than when it was negative, but there was not sufficient difference to justify the use of such a method as a means of comparing electrode qualities, nor did it appear that the electrical conditions in the circuit during the process of welding could be used as a criterion of the soundness of the welded joint.

A second series of experiments had the object of finding out whether the method of controlling the current used for the arc had any effect on the quality of the welded material. Two pairs of plates were welded by hand, the current in one case being controlled entirely by resistance, and in the other case largely by reactance. The result of fatigue and tensile tests carried out on these specimens showed that the fatigue strength and character of the metal deposited at the welded joint were not seriously affected by the nature of the current and pressure regulating arrangements. Dr. Marchant also devoted much time to the development of the design of an apparatus which would enable faulty places in a weld to be detected, and had constructed a tester which might be useful for determining faults in a weld or cracks in a flat plate.

Mr. E. R. Dolby said he wished to offer two or three words of reminiscence and to ask a question. He was driving along the embankment in a hansome cab one day and saw the roof of Charing Cross station suddenly fall in; they were not many people, he thought, who saw that accident. The result, as probably a great many members knew, was due to the breaking of the welded joint of a tie-rod. A short time ago he had the interesting experience of seeing some sections cut through the defective welded portion of that very tie-rod; it was about 4½ inches in diameter and there was a hole as large as a hen's egg right through the welded section. When reading the paper the question arose in his mind: Would any process have discovered the defect in that tie-rod at the time, or shortly after, it was made? He could see no prospect, from what had been said in the paper, of any test being made that would have proved the unsoundness of that rod.

Captain David Richardson, R. A. F., said it would probably be of interest to the members to know what had previously been done in the way of standardization in the testing of welds. At the Congrès International des Méthodes d'Essais, held at Zurich in 1895, a method of verifying the quality of welds was proposed. In 1912 the Bureau Central de l'Acetylene and Soudure Autogène of Nuremberg offered a prize of 1,500 marks for the best solution of the following question: "In what manner may the presence of oxide inclusions, unwelded portions, and the burning of the metal be discovered in an autogenous weld without damaging the line of welding?" There were twenty-six entries, none of which were satisfactory, and of which five gave possible lines of development. The application of electrical and magnetic methods had proved to possess serious difficulties. The electrical resistance method of determining the presence of cracks was dealt with in an article in the Revue de Métallurgie of January, 1913. At the present time the Office Central de l'Acetylene of France were engaged in a series of official tests for establishing methods of testing welds.

With regard to the paper, it was interesting to note that the American Bureau of Welding was a product of the war, and practically the whole of the programme, of which the paper represented one item, was only fixed at the latter end of 1920. The Emergency Fleet Corporation formed a Welding Committee, which comprised representatives from England. With the close of the war, when the government withdrew from the activities created by it, the American Welding Society was formed to carry on the work. From this emerged the American Bureau of Welding, the functions of which were to establish and standardize the facts, to conduct researches and to furnish a sound basis for an industry which was bound to become of the first magnitude. The standardization of testing welds was only one of the items in the programme. He was of the opinion that some of the other items were much more important at the present time, for instance, the standardization of welders and equipment. The necessity for elaborate tests which, in many cases, were of little real value, would disappear with well trained and conscientious welders. The practical test of a weld was the character and training of the man who made it.

The value of tests on welds was often negatived by the procedure followed. A specimen weld was generally taken

machined or turned up, thus frequently eliminating one of the most serious defects of welds, namely, lack of penetration. With reference to the bending test, he had found that this tests was of great value in training welders, but the bending was not applied as shown in the diagram. The question of preliminary tests on the materials, which in the case of oxy-acetylene welding would include a blow-pipe test, was very important. In view of the enormous value of examining welds in situ, he forcasted that the development of X-ray examination would lead to its establishment as one of the chief, if not the chief, method of examining and testing welds. He had found that simple etching tests were of great value.

Dr. B. P. Haigh agreed that it was most desirable that some method should be found for testing finished welds in structures; but as no convenient method was at present available for this purpose, it was necessary to rely on tests on special samples. As the author had stated, much depended on the proficiency and integrity of the individual welder. He thought that only two sets of standards were really important, namely, (1) Shop-tests to ascertain when a welder had attained a reasonable standard of proficiency, and (2) a series of standard tests for specifications. He did not doubt that research would continue to look after itself in the matter of standards.

The tensile test could no longer be regarded as a sufficient criterion of strength, particularly when the results were given as percentages of the strength of the plates. Having had an opportunity of testing a series of twenty welds produced by the Kjellberg process, he had found that not one of these broke through or near the weld.

With regard to fatigue tests, which the author wisely recommended for specification purposes, he did not think the type of machine described in the paper was the most suitable. In any rotating-beam test, the results depended unduly on the metal at the outside. Whereas a test-piece with a large flaw near the centre might give good results in such a test, the presence of only a slight flaw near the outside would give a poor test result. It was greatly to be preferred that the stress should be uniformly distributed across the full section, as well as along a considerable length. He had obtained very successful results with a machine that fulfilled these requirements and worked, moreover, with a much higher frequency of reversal, thereby reducing the time required for the completion of a test. He deprecated the author's statement that fatigue tests were necessarily arbitrary; the limiting fatigue stress could be measured with very great accuracy in a suitable machine. The figure suggested by the author as a standard fatigue strength appeared to be suitably chosen. In a series of tests on Kjellberg welds, more than half the number of test-pieces had withstood over five million reversals with stresses over 10 tons per square inch.

Although the author had mentioned the impact test among the headings under commercial tests, no standards had been suggested. As the impact test often revealed brittleness in welds that gave good results in other respects, that omission was an important one. The Izod test was a simple and practical one, and deserved careful consideration for welding work. It could be recommended as a shop test, and appeared preferable, for this purpose, to the bending test described by the author. The Izod test always broke the test-piece, so that the fracture could be examined; a matter of great importance since the characteristic appearances of tough and brittle metal were now well known. Another excellent shop test was the torsion test, carried out by twisting a sample composed wholly of added metal. By measuring the number of turns obtained on, say, 100 diameters, and observing the uniformity of twist along the length, it was possible to form a very reliable opinion of the degree of proficiency attained by any individual welder, working under specified conditions, as in "overhead" work. It was not unreasonable to expect thirty complete turns on a length of 100 diameters.

For photomicrographs, a magnification of 100 diameters was not the most instructive for studying welds, although it was suitable for general purposes. At this magnification, all welds appeared more or less alike, and the characteristic features that made for toughness or brittleness were not clearly indicated.

Dr. T. E. Stanton, C. B. E., member of council, said he quite agreed with the other speakers who insisted on the value of the impact test. In a weld the heat treatment of the metal was very severe, and he thought there might often be set up in the neighborhood of the weld a form of brittleness which could not be detected by any other mechanical test but the impact test. He also agreed with the speaker who said that the standardization of the welder was equally necessary. If it were possible to get some sort of examination which a welder could undergo, it would be a very good thing. He believed that, during the war, ex-service men were taken, who had had no training, and in six weeks were turned into efficient welders. In South Wales the other day he had seen, in welding gas-cylinders for high pressures, that every welder had his own little stamp, and when he made a weld he stamped it so that it might be identified, and this practice, he thought, might also be adopted.

The president thought that Dr. Stanton's view was to test the welder not the weld.

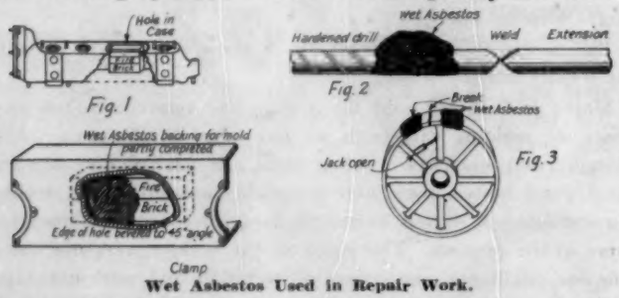
Major J. Caldwell said the author had referred to the absence of welding standards of any kind in America. Although comprehensive welding tests had been undertaken in the United States, they were invariably carried out by welding enthusiasts, or on behalf of large users or prospective users of the process. The result of the former were not suitable for intelligent comparison of materials and workmanship, whilst for obvious reasons the latter had to be considered confidential and withheld from competitive parties interested in the manufacture and supply of the electric welding material and apparatus used. During the war many of the latter tests were communicated to this country, and he was glad to have the opportunity of acknowledging the useful purpose of certain unbiased and careful investigations carried out on behalf of his company by Mr. E. B. Katte, chief engineer of the New York Central Railroad Company. The Wirt Jones tests represented an attempt at standardization on the part of the Welding Committee of the Emergency Fleet Corporation of the United States Shipping Board, but those tests were not convincing, because no attempt was made to standardize the operation and the method of executing the work. He was justified in making those remarks because he was one of the original members, and represented the Admiralty on the American Welding Committee. In this country we have been more fortunate in standardizing tests of welded joints. The testing of electric welds had engaged the practical attention of the Admiralty and Lloyd's Register of Shipping during the last three years, with special reference to shipbuilding use. Both those bodies had found no difficulty in adapting to welds the methods which they had developed during many years for testing materials and the reliability of workmanship in shipbuilding.

It was doubtful whether there was any great advantage to be gained by standardizing the size of test-pieces. The size necessary to test a weld under conditions approximate to those in use might vary very considerably. For example, for butt or lap welds in ship plates or similar structures, it was more representative to use a large width of plate than to cut out a narrow specimen which might or might not be fairly representative of the whole weld. Lloyd's tests included specimens 20 inches and 48 inches wide, and clearly a riveted test-piece of 1½ inch or 2 inches would not give the true strength of riveted joints.

VARIETY OF USES FOR WET ASBESTOS

A Welder Suggests a Number of Ways to Get Better Results by Using This Heat Insulator

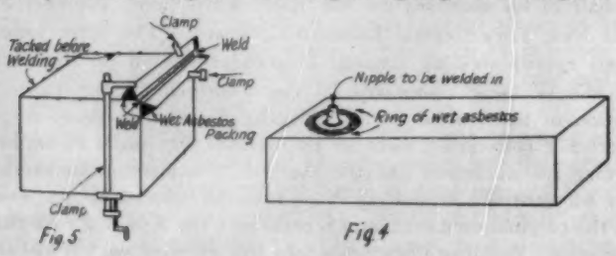
HEAT is the welder's willing servant, but in order to be most useful to the welder heat must be controlled and regulated and this is where asbestos paper plays its part. Due to the fact that it is a mighty poor conductor of heat and at the same time resists high temperatures successfully, asbestos paper has been used for years in the welding shop and is almost as necessary to the welder as the welding torch itself. The greatest use for the dry asbestos paper as it comes from the mill is to cover up castings while preheating and cooling down to prevent the heat from escaping from the casting where it is needed, to the air where it is not, and to protect the welder from the heat while working on the casting. These are probably the greatest uses to which the dry or sheet asbestos is put, but by the addition of water, a little working up and the welder's own ingenuity the uses of



Wet Asbestos Used in Repair Work.

asbestos are multiplied a hundred fold. Only a few of the many applications to which wet asbestos may be put are given here as examples.

It is often necessary for the welder to supply missing parts of automobile crank cases, especially when holes of large diameter are knocked in the case, either the upper or lower half by a connecting rod breaking and going out through the



Prevents Buckling in Sheet Metal Jobs.

side of the case. These holes are often of very irregular shape and may necessitate a patch being put in of varying thickness, even from ⅛ inch to 1 inch where the break runs into the bearing web or motor support legs. There are several ways of doing a job of this sort and they may be classed as follows:

1. Cutting out a piece of sheet metal, aluminum in the case of an aluminum crank case, and fitting in a patch, which is a poor job at the best.

2. Blocking up in back of the hole with a plate, usually copper when working on aluminum, and flowing in rods until the space is filled in flush with the surface, this method is a gas waster and generally causes contraction cracks to be left which have to be soldered.

3. Having a casting made the exact shape and thickness of the missing part or parts whether of cast iron, aluminum or bronze and welding this casting in.

This is in the writer's opinion the cheapest and by far the best method, because, there is only a small amount of welding to be done, just around the edges of the patch. There is an equally small amount of contraction to be taken care of, as against the large amount when the hole is filled in by flowing in rods as in method 2.

To make such a casting at first thought may seem a difficult job, but not so if we turn to the useful asbestos roll for help.

First bevel all around the edge of the hole in the case to a 45-degree angle with a half round file, from the outside. This is done so that the pattern we are going to make will lift out easily and at the same time leaves one-half the job prepared for welding. Next, block up inside the case with fire brick to within an inch of the edge of the hole (Fig. 1). Take some dry clean asbestos paper that has not been burned, tear it apart and shred it up well, put it in a bucket and pour in water until it will absorb no more, mix up well until about the consistency of dough and then fill up the hole in the crank case level with the inside edge, smoothing down all lumps with fingers and shaping this form to the exact shape of the piece missing. When this is done take a piece of tissue paper and line the form or mold with it, oiling it well to make it lie flat and conform to the irregularities of the casting, and into this pour a thick soup of plaster of paris and water. While the plaster of paris is hardening you may build up lugs or brackets that may be missing to suit yourself. When it is well dried out, tap the case lightly to loosen, lift out plaster of paris pattern, smooth down high spots or rough places with a knife or file, bevel edge to a 45-degree angle the same as the edge of the hole in the case and you have a pattern for the missing part that any convenient foundry will cast you a piece from, at the cost of a few cents a pound.

In welding extensions on the end of twist drills (Fig. 2) it is essential to keep the heat from spreading to the hardened flutes of the drill. A lump of clean, well-soaked asbestos placed close to the weld and packed around the drill will check the heat from spreading any further than the asbestos. This idea may be applied whenever it is desired to protect a hardened surface on any article, especially tools.

In welding broken pulley rims and spokes it is often necessary to do the job in place on the shaft in an emergency. By covering the rim with wet asbestos close up to the weld and keeping it drenched with water to confine the expansion to the weld alone it is quite possible to make a repair on a broken pulley rim that will hold until it can be taken down for a permanent job. (Fig. 3.)

Wet asbestos will also prove a big help to confine the heat from the torch to a small area when welding in the center of a steel sheet or plate to prevent buckling and warping as in putting in a nipple or connection in tank work. By building a heavy ring of wet asbestos around the part to be welded to the sheet or plate and keeping it soaked with water during the welding operation the heat may be kept from spreading into the sheet beyond the asbestos ring. (Fig. 4.)

Another plan that may be followed with good results on light gauge sheet work where jigs are not available or the quantity does not warrant an expensive preparation and it is desired to turn out an article free from buckles in the area adjoining the welded seam is to fill the V of suitable size angle irons with well-soaked wet asbestos paper and clamp

them upside down parallel to the seam to be welded and as close to it as possible, one on each side. (Fig. 5.)

This will effectually check the spreading of heat and limit the expansion to the welded seam itself.

Another useful application of wet asbestos is in welding broken automobile frames where the break is located under the body of the car, or near woodwork and painted surfaces. When the break to be welded is under the body and it is inadvisable to take the body off entirely remove the bolts that hold it down to the frame, loosen up all connections between body and chassis, jack up the body directly over the break in the frame until you have a space of at least 6 inches between the wooden body sill and top flange of the frame. Block body securely in place. Now plaster a heavy covering of wet asbestos along and under the woodwork of the body, covering up all painted surfaces that will be reached by the heat of the torch and you can weld to your heart's content without fear of scorching expensive finish or damaging the body in any way.

Welding Ford motor support legs with the motor in place is entirely practical. It is only necessary to remove the floor boards, cover all exposed surfaces generally with wet asbestos, drain gasoline out of the carburetor and weld with as small a tip as possible.

CONSUMPTION OF FUEL GASES

In an article entitled, "Industrial Gases and Their Containers," which appeared in a recent number of Chemical Age, Mr. Edward O. Benjamin discusses a new method of testing gas cylinders. Some of his preliminary remarks on the use of compressed gases are of considerable interest, indicating the tremendous market for acetylene, hydrogen, oxygen, etc.

"Industrial gases," says Mr. Benjamin, "have become an important commodity in manufacture and commerce. Their importance as an instrument of warfare was demonstrated in the World War. The general method of distribution of gases involves their compression into steel cylinders, and their shipment in these readily handled containers. In some instances the gases, upon being compressed, simultaneously become liquefied and remain in a liquefied state while confined within the cylinder.

"As an example of the extent of the industrial gas industry, it may be said that there are over 5,000,000 gas cylinders in service in North America in the transport of the manufactured gases described in this article. In the description of each gas emphasis is made of the importance of their respective utility, the number of manufacturing plants producing the several gases and the number of cylinders used in each case.

Acetylene

"Acetylene (C_2H_2) is used for welding and cutting of alloys of iron and similar metals, for the removal of wreckage, building tanks, boilers and even steel ships. It is extensively used for illumination, both portable, as in the case of the automobile, marine buoys and lighthouses, as well as for illumination and fuel in isolated buildings. There are 16 commercial manufacturers filling cylinders with acetylene at 65 filling plants scattered throughout the country. There are an enormous number of isolated generating plants which are not considered here as having any connection with cylinders, as the gas is piped directly from the generator to the point of use. In this industry no less than 2,500,000 cylinders are in service. These cylinders are made and tested under Specifications No. 8 of the Interstate Commerce Commission.

Hydrogen

"Hydrogen (H_2) is used chiefly in the hydrogenation of oils, production of synthetic ammonia in conjunction with nitrogen, filling balloons, cutting of metals in conjunction with oxygen, reduction of metals, a fuel in the manipulation of glass, the production of synthetic sapphires and other gems, fusing of silica, platinum, lead-burning, etc., treating of wool, annealing of steel and as a heating agent in conjunction with oxygen for lime lights. There are 58 commercial manufacturers of hydrogen filling about 200,000 cylinders at 86 filling stations scattered throughout the country. In addition to these there are a large number of industrial plants which manufacture hydrogen for their own use, and do a limited amount of filling or shipping, bringing the total number of hydrogen generating stations to 195, involving the use of no less than 10,000 additional cylinders. These cylinders are made and tested under I. C. C. Specifications No. 3-a.

Oxygen

"Oxygen (O_2) is used in conjunction with fuel gases in the welding and cutting of metals, enriching air for blast furnaces, for breathing apparatus helpful in cases of pulmonary diseases, prolonging life, mine rescue apparatus, self-contained diving apparatus and gas helmets and masks, as well as gases in conjunction with anaesthesia, such as nitrous oxide, ethyl chloride and ether. It is used in the oxidation of oils; the preparation of ozone for disinfection, bleaching, sterilization of water and air, and for the synthetic production of vanillin and artificial camphor. The use of oxygen in the laboratory is unlimited for carbon determinations by the combustion method and as a rapid oxidizing agent where high temperatures are wanted, and in metallurgical operations. There are at present 67 commercial companies, filling cylinders with oxygen, at 149 plants throughout North America, and in addition to this there are 93 companies, operating 124 industrial plants. All told, there are about 1,500,000 cylinders used for the distribution of oxygen. The cylinders are made and tested under I. C. C. Specifications No. 3-a.

Fuel Gases

"In addition to the above-mentioned gases, there are a large number of fuel gases, consisting of hydrocarbon gases or vapors, some of which also contain carbon monoxide. These gases are sold under various trade names, such as Blaugas, Butane, Calorine, Carbo-Hydrogen, Coal Gas, Gasol, Kutting Gas, Petroleum Gas, Pintsch Gas, Pyrogen, Thermalene and others. Most of these are mixtures of various hydrocarbons such as methane or marsh gas (CH_4), ethane (C_2H_6) and in some instances propane (C_3H_8), propylene (C_3H_6), olefiant gas or ethylene (C_2H_4), benzine vapors, particularly light fractions obtained in the distillation of petroleum. These gases are generally obtained by the destructive distillation of coal, wood, oil or other carbonaceous materials. Some are producer gas, water gas, casinghead gas; some, again, are by-products of chemical industries.

There are no less than 17 manufacturers who maintain 38 filling plants throughout the country, these gases being used chiefly for cutting metals, fuel and illumination, and to a very limited extent directly for chemical combination. However, the number of cylinders involved is quite large, being due to the fact that many of these are used in isolated sections, where transportation facilities are limited. Cylinders used for these gases are tested under I. C. C. Specifications No. 3 when the gases are liquified and their charging pressure at 70° exceed 300 lbs.; under Specifications No. 3-a when the gases are not liquefied; under Specifications No. 7 when the gas is not liquefied nor in solution, and the charging pressure does not exceed 300 pounds per square inch; and under Specifications No. 26 for liquefied petroleum gas, charging pressure not to exceed 1,000 pounds at 70° F.

"From this brief description of industrial gases it is obvious that they are sufficiently important to require special regulations in handling and shipping. For this reason the manufacturers of these gases, as well as the manufacturers of cylinders and valves are continuously co-operating with the Bureau of Explosives and other authorities to render their handling as safe as possible."

WELDING IN THE STEEL PLANT*

How the Acetylene, Electric Arc and Thermit Welds Are Applied to Special Maintenance Problems

By Walter Petry†

THE subject of autogenous welding has become so broad that it is only possible to go into detail on the most important points, and new developments, in this paper.

Due to the rapid progress welding has made, and to the fact that so many different parties were deeply interested in it with no common method of benefitting by each other's knowledge, it is impossible for any one man to make a collection of all information on the subject. Therefore, it is hoped that this paper will start a discussion that will be of great benefit to all interested parties.

There are three methods of welding in use, which covers a field so broad that we can unhesitatingly say that any metallic substance can be welded successfully. However, there are several forms of welding, such as Electro Percussive and Spot Welding, that apply more to manufacturing of certain articles than to Maintenance of Steel Plant Machinery and equipment. These will receive only mention in this paper.

To enumerate in the order of their least importance the three most useful steel plant welding methods, Thermit is first; Acetylene is second; and Electric Arc Welding is third. Each of these has its own definite field of aplication, which in each case overlaps the other to some extent, consequently, a thorough knowledge of cost, reliability and time required to make the weld are necessary in order to choose the best method.

Fields and Boundaries

All heavy sections where a continued addition of strains would be set up by metal electrode, or acetylene welding in adding metal, building up a surface or filling in a fissure, should be thermit welded.

This gives an even distribution of heat over the entire member and gives a resultant weld approximately the same as a cast steel section.

Thin sections of cast iron in all cases should be gas welded, however, if it is impossible to preheat properly, a patch job may be made by studding the edges of the fracture and welding with metal electrodes. All alloys, other than steel, should be welded with gas.

All steel welds, where it is not necessary to make more than two layers, or where locked up strains have no direct importance, should be done by the Electric Arc Process. Extremely thin sheet metal and odd forms should not be welded electrically, but should be Gas Welded.

The Thermit Weld

The field of Thermit Welds lies in heavy, broken sections and additions to original stock. Another very useful application is in making welds of special analysis, such as high carbon and high manganese, where wearing qualities are very essential.

Plain thermit is a mixture of Iron Oxide and Granulated Aluminum in the ratios of seven to three parts respectively. Railroad thermit has the same ratio of Iron Oxide to Aluminum as plain thermit, with 1 per cent Manganese, 15 per cent Steel Punchings and 5/8 per cent Nickel added. In making additions of manganese and carbon for special hard jobs, manganese may be added to Railroad Thermit in the pure form or in high percentage fero-manganese. The manganese will depreciate approximately one-half through the reaction, part pasing off with the fumes and the other being held in the aluminum oxide.

Any percentage of carbon may be added, but care should be exercised in selecting the proper form of carbon, for it must be in such form that it can be quickly and completely dissolved by the steel and it must also be in heavy enough form to prevent the gases and fumes in the reaction from carrying it off to the atmosphere. A finely granulated anthracite coal has been found to be the most advantageous form of carbon to use. By exercising great care, the carbon and manganese content of alloy welds made in this manner may be made to come within .10 per cent of desired analysis.

In making a thermit weld it is absolutely necessary that all parts must be thoroughly cleaned. The broken section should be examined carefully to ascertain any further fractures caused at the same time the main break took place. If any of such are found, care should be taken to cut such part off entirely and replace with thermit weld.

The broken parts should be lined up carefully, making the machined surfaces, if any, after allowing for contraction, exactly the dimension of the original piece or according to the print. There should be cut from either side, or both, enough of the broken part to leave room for preheating and enough body for the thermit steel to carry sufficient heat to weld in deeply.

In estimating the contraction that will take place, it is necessary to take into consideration the fact that the temperature ranges from 2,700 deg. F. down to atmospheric temperature. The high temperature of the weld will cover only a few inches of the member and does not set up strains until the metal begins to solidify, the heat of the weld will cause the broken members to elongate still more than the preheating, so that in very accurate work close estimation of the expansion of parallel members must be exercised.

After thoroughly cleaning and properly lining-up the fracture, a wax pattern is formed exactly the shape of the desired finished weld. The speed of making this pattern can be increased on plain patterns, by making a case around the break and pouring hot wax in, allowing for trimming down to proper dimensions, or where the wax must be formed by hand, it should be allowed to heat very slowly all the way through, until it becomes plastic and easily formed. The job is then ready to be molded.

The surfacing sand in the mold must be of a very refractory quality, consisting of one part plastic clay, 3 parts silica sand. Special caution must be taken in ramming up the mold not to damage the wax pattern and also to ram the sand very hard so it will withstand the heat and vibration of the preheating flames.

The heating gate should enter the bottom of the mold and be directed so that the flame will spread evenly over the entire broken surfaces. Where it is impossible to use the riser as a pouring gate, it is necessary to take precaution to have the pouring gate carefully surrounded with facing sand, thus eliminating the hazard of blocking off the thermit steel.

The mold should be vented to permit gases and vapor from the wet mold and steel to escape. These vents should be put

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in after the mold is rammed up and should go within ½ inch of the face of the wax pattern at an angle of 30 deg. or greater. The mold should be thick enough to insure strength for retaining the steel and not permit cracks, caused from the mold drying out to extend to the box containing the mold. A good practice is to make the mold wall not less than one and one-half times as thick as the wax pattern is wide.

The pouring gate should enter the mold at the extreme lower point, permitting the metal to rise through the space occupied by the wax pattern; in some cases the risers should be used for gates. Risers should be placed on all high points with enough volume to add metal to the inside of the weld as contraction begins before solidification of the steel is complete.

Preheating to the correct temperature is very essential and where a heavy section is to be joined to a lighter section, bcomes an item for careful consideration. The wax pattern should be allowed to melt and run out into a container. The speed of this operation from heating can be greatly increased by making an opening from heating gates to risers, either by a stringer previously inserted or drilling with wood bit or melting with hot rods, as may be most convenient.

A proper flame regulation is essential for time and cost economy, for it is necessary to have a delicate adjustment in order to have correct volume plus correct mixture in using either gas and air, or kerosene and air for the fuel supply. The flame should be neither carbon depositing nor oxidizing in order to get speedy and nondestructive results, but should be positively a neutral flame.

Since it is only possible to judge the heat of each piece by the eye, there should always be a riser set in such a way that both parts are visible, while the preheating is taking place. A dark cherry red has been found to be the best temperature for light welds, while a yellow heat should be reached on heavy welds.

After the proper preheating has been executed, the heating gate should be carefully closed by inserting a piece of dry fire-brick to fit the gate near its entrance to the weld cavity. Sand is then rammed in to completely fill the heating gate. A plate or clamp placed over the entrance effectively blocks the sand and holds the pressure of the steel.

While preheating is going on, the crucible should be prepared for the reaction. The "stone" should be inspected carefully and, in case the old thimble is cut by previous reactions, a new one should replace it. The tapping pin is then inserted, followed by washer and plugging material to effectively plug the opening and permit quick and reliable tapping. The thermit is then placed in the crucible, at the same time putting in any additions that may be desired for the job at hand. The crucible is then rigidly supported above the mold, accurately centered over the pouring gate, and ignition powder, consisting of a mixture of barium peroxide and pulverized aluminum, placed in the top of the thermit.

The reaction starts by touching off the powder with a match or red hot rod, which forms heat sufficient to start the reaction between the aluminum and iron oxide. The reaction is self-supporting and reaches a heat of 5,000 deg. F., at which temperature the steel, in a highly superheated state, has separated from the aluminum oxide and is tapped out first. The reaction takes from 30 to 70 seconds, the completion of which must be judged by the eye. As soon as the smoke recedes slightly, the operator forces the tapping pin up into the hot steel, permitting the latter to pass through the thimble into the mold. After the heat is poured, the surface is covered with sand and allowed to cool from five to twenty hours, depending on the size.

The crucible is kept in serviceable condition by replacing stones, thimbles and relining with magnesia tar when necessary. By exercising care and judgment, a crucible should run fifteen heats before relining becomes necessary, but it is nearly always necessary to replace the thimble. The preheating torches are very simple and require very little attention or repair.

The field for Thermit Welding is broad, covering all heavy jobs, such as housing, heavy frames, roll necks, pinions, wobbles on spindles, hard wearing faces, and in fact any heavy cast iron or steel part in the Steel Mill that is subjected to abrasive use.

Oxy-Acetylene or Gas Welding

The field of gas welding covers the largest assortment of jobs of either method, for the heat can be controlled positively and does not change the composition of alloys to any great extent during the process of welding.

Acetylene gas, from which this process derives its name, is a hydro-carbon gas, by weight 24 parts carbon and 2 parts hydrogen. Being practically gaseous carbon, it is the most powerful fuel obtainable and when properly mixed with pure oxygen forms complete combustion and the resultant gases, which are principally carbon dioxide and water vapor, are practically neutral or inactive with the molten metal being welded.

Where a quantity of gas is to be used, it is always less expensive to generate the gas direct from calcium carbide, but where it is necessary to have equipment easily portable, acetylene should be used in the dissolved and compressed form.

Oxygen, the other element of importance in gas welding, is obtained from water in the Electrolytic process and from air in the Liquid Air Process. With the advent at this time of oxygen being made at a cost of one one-hundred and fifty-fourth of that in the past, gas welding should take a quick step forward and be applied more than ever to Steel Plant maintenance and operation.

At the high temperature of welding point, steels and other metals easily oxidize, when in contact with free oxygen or when exposed to the air, so that it is necessary and very essential to use some means of protection. This can be done by applying flux as the weld proceeds. In many metals there are elements whose specific gravity is practically the same as that of the molten metal itself. There again a flux should be used.

In selecting a suitable flux, it is necssary to know what purpose it is to serve; whether it is merely to protect the surface; or whether it is to float impurities and oxides to the surface, or dissolve such impurities and prevent them from going back into the weld. There are many manufacturers of welding equipment making fluxes, some of which have stumbled on to combinations of chemicals, etc., which seems to give them good results. Others, however, have studied the subject thoroughly and have placed on the market a flux for every different condition or combination that may arise. The use of the latter is advisable.

Other equipment for gas welding consists of regulators, hose, torches, rods and goggles. Good standard regulators are very essential for successful gas welding, for upon the even flow of both gases depends the purity of the flame and quality of work. Hose should be of high quality rubber, treated to withstand the chemical action of gas and strengthened sufficiently to withstand the maximum pressure under which the gases are used. Flexibility in the hose is a very helpful quality and should always be considered in making the selection.

The final mixing of the gases takes place in the head of the welding torch, by means of several different patented methods. It is these differences that classify torches into two distinct types, namely, high pressure and low pressure. The design of the high pressure torch uses the principle of gases flowing at high speed and striking each other at an angle for perfect mixing. This type is very successful and free from common trouble of back-firing, but this type depends on both

gases being regulated directly by the thumb valves and, therefore, a perfect mixture depends entirely upon the operators steadiness in adjusting to form a neutral flame. The low pressure torch works on the injector principle, permitting the acetylene gas to enter through a large opening and then to be injected by the oxygen to the welding tip. The oxygen moves at a high speed and swirles the gas, expands and contracts it before it reaches the final orifice. The prime quality of the low pressure torch is that as the oxygen increases the gas increases also, so that the operator has practically a micrometer adjustment to control the flame and as the pressure varies, if it should through slightly faulty regulators, the rise and fall is balanced in both gases and does not, therefore, change the mixture in the head as does direct high pressure mixing. The low pressure torch also has the advantage of using more nearly the complete amount of gas in a compressed tank.

All jobs should be thoroughly cleaned and properly "V'D," permitting the operator to weld completely through the metal. They should be lined up, allowing for expansion before the welding operation starts. The angle of the "V" should be 60 deg. to 75 deg., depending on the thickness.

Preheating of certain jobs to portect against cracking from the heat of the welding is very important and much could be said on the subject. However, by the application of carefûl thought and the knowledge of the rate of expansion of different metals under heat, the problems of expansion and contraction can be readily and successfully solved. The main object is to permit parallel members to elongate as much as the members to be welded and then to permit them to contract to normal length again at the same rate. Preheating also serves the purpose of economizing on welding labor and welding gases, for it is much cheaper to heat with natural gas or kerosene torches than with welding torches.

The operation of Acetylene Welding is simple to understand, but to become an expert in use requires much careful practice. In starting a torch both gas and oxygen should be permitted to flow through the hose separately until it is positively known that each contains its respective gas to insure against explosive mixtures of air and gas. The gas valve should then be opened and the torch immediately applied to incandescent heat in the form of match, Pyro Lighter, Electric arc or formerly preheated job.

The surface of the two parts to be joined should be heated to flowing before any addition of filler rod is applied. The filler should always be applied while there is large enough body of molten metal to cause it to flow and penetrate deeply into the parts to be joined. The weld should progress at a uniform rate of speed with a cross-wise motion of the torch always advancing and not passing through the molten metal.

The rods should be selected to correspond in anlysis to the material to be welded, except in some few cases such as malleable iron where it is necessary to use a bronze filler in order that the destructing temperature of melting point is not reached.

It has been found by careful investigation that the chemical properties of metal passing through the flame of gas welding do not change to any marked degree, but always tend toward a purer metal by reducing slightly such elements as carbon, manganese, etc.

The welding equipment should be kept in first-class operating condition by careful inspection and by repairing wearing and damaged parts, for in the perfect operation of the equipment and absence of leaks, lies much of the efficiency of gas welding.

To enumerate some of the common repairing jobs around the steel mill, we find a varied field for gas welding, such as motor feet, end bells, commutator segments, controller parts switch points, pliers, wrenches, tongs, lathe tools, high speed and high carbon steel stellite, alloy kettles, galvanized kettles, thermo-couples, pump cases, brasses, hydraulic valve seats, grate bars, malleable castings, monel acid resisting chains, and from the garage aluminum crank cases, water jackets, frames, springs, and many others.

Electric Arc Welding

Electric Arc Welding, by which more numerous repair jobs are done, is of great interest and is more fascinating than either of the other forms of welding. While its field is not so broad as that of gas it is applied ten times to one of gas welding, and, for that reason, holds a closer relationship to the steel industry than does either of the other welding methods.

Electric Arc Welding is divided into two processes, namely, the carbon arc and the metallic arc.

The carbon arc process is used for putting on large quantities of steel such as are required at times in steel foundries to fill up holes left by risers and to reclaim defective castings. Repair work where a great amount of heat is required to heat the job is often speeded up by the use of the carbon arc. Such work as bolt holes in shaft couplings and holes in Annealing Covers are best welded by the carbon arc. The field of carbon arc welding has been greatly limited by the development of metallic arc welding to the extent that the carbon arc process is almost extinct.

The metallic electrode in its highest developed form is revolutionizing methods of manufacture and has a very marked influence on maintenance of steel plant machinery.

In this form of welding D. C. is the popular form of electricity used, although A. C. with special coated rods, can be used successfully. The principle made use of is that upon breaking the electric circuit, an arc is formed of very intense heat, which, when controlled, can be made to perform the function of depositing metal in small quantities on the surface of some other metallic object.

The heat is greatest on the positive side and forms a crater in the molten metal, while the negative side tends toward drawing to a sharp point.

For the above reason it is much more effective to use the electrode on the negative side. The metal is forced away from the electrode by a rapid succession of minute explosions approximately at the rate of forty per second. Each explosion drives a small particle of globule of steel from the electrode to the crater. This particle, while at a greatly superheated temperature, unites with the base metal and solidifies in one homogeneous mass. This fact makes it possible to weld overhead as well as straight down, and, of course, in any other direction as long as it is possible to hold the electrode at right angles to the crater.

A change of polarity will cause a sputtering and occasional heavy explosion, sending steel globules with high velocity at random, from the end of the electrode. This is caused by the tendency of the positive side to form a crater in the molten metal, and when volatile substances form behind that crater and expand rapidly, the metal then suspending from the electrode flies off, but in no definite direction.

The size of the electrode and current density are determined by the speed at which the deposit is required or permitted to be made. It is only when the size of the rod goes above the size of the surface covered by the arc that real trouble begins. On larger rods, no matter whether the current density is increased with the size of the rod, it is found that the surface covered by the arc on the negative side stays about the same in size, but increases in intensity, thus making the arc travel around over the surface of the electrode cooling down at some places and forming deposit globules at others. It is this feature that limits the size of electrode and amount of current that can be used in combination.

The selection of a standard rod, uniform in composition and possessing special welding qualities is a very important step toward successful work. Rods drawn with a smooth sur-

face and a uniform tensile strength with the surface hardened by a cold pass through the dies, have been found to give the most satisfactory results.

Electric Arc Welding, due to the great intensity of the light and the presence therein of the very injurious ultra-violet and infra-red rays, carries with it a great hazard for the eyes and skin, which must be protected by helmets and heavy clothing. Any lens which effectively screens out the ultra-violet rays and tones down the intensity of light until it is possible to watch the exact action of the little globules and motion of the arc on the electrode and crater, is recommendable.

The field of electric arc welding is limited to light sections, except in cases where excessive strains set up by contraction of the metal, has no direct importance.

To enumerate some of the steel mill jobs, we have gear guards, drain pans, concrete forms, saw teeth, gear teeth, journals on shafts, journals on armatures, taper ends, key-ways worn surfaces on housings, worn spindles, coupling boxes, all tee bars for crane electricity supply, track wheels, shear knives, steel kettles, packing glands, Open Hearth doors and door frames, port coolers, bulk head coolers, hydraulic pipes, valves and fittings, steam pipes, water tanks, boiler flues, fire boxes, shear crabs, clutches, Open Hearth furnace gas valves, gas producer pokers, bar guides, and, in fact, any steel part in a steel mill that is subjected to wear or breaking strain and that does not fall in the classes mentioned before.

A very important item in placing a job in the class of welding best suited for it is the consideration of chemical changes on the resultant metal. Since in thermit welding the carbon and manganese content can readily be regulated and in acetylene welding the composition does not change to any marked degree, electric is the method which should be brought to perfection in controlling these additional elements. For years we have made additions of carbon and manganese by coating the electrodes with the same, but this is very crude and irregular in its results. It is known that the carbon content of a steel rod reduces about thirty points (.30) while passing through the arc, when the operator maintains a steady short arc. It is then only necessary to use a rod thirty points higher in carbon than the resultant weld is to be, but since the welding qualities decrease as the carbon increases, it can be readily seen that there should be some other method of increasing the carbon and manganese.

In conclusion then, a comparison of the physical properties shows electric welds to be more brittle than gas or thermit welds, which, of course, limits its use to some extent. The great variety of work where brittleness is not a harmful factor, but where wearing quality is the prime factor, makes electric welding the leader of all welding and the greatest short-cut in salvaging worn out steel mill parts.

Discussion

H. C. Cronk: Mr. Chairman and Gentlemen: I would much have preferred if the Chairman had called on some of the men posted on welding who I am sure are present, for opening this discussion, but I have made several notes on Mr. Petry's paper and one of the first things I think in connection with electric welding I noted particularly. I am only, by the way, interested in electric welding. I know nothing about gas or thermit. I shall leave that to you who are better posted.

One thing was brought out forcibly in the last part of the paper. I think the prime thing, and the thing we get up against most frequently, is the treatment of the material or equipment to be welded. I believe we have more trouble, and I believe there is more for the electric welder to learn in the actual treatment preparatory, and after the weld is made, than in actually making the weld. Just as Mr. Petry explained in his last remarks, with the large job of enormous volume; without proper treatment the whole job could have been ruined very easily after the weld was made. I am not, understand, belittling the welder at all. It takes skill and training to become a welder, but without the other knowledge a welder certainly is not a finished mechanic.

Mr. Petry brought out, in his opening statement, that he believed all cast iron welds should be acetylene welded. Well, I don't agree with it. I believe just as good a job can be made on the whole with electric, and we do it every day, and do not pre-heat either. I do not say that we do all our jobs without pre-heating, for the reason that we must take care of such things as welding of the housing, but I believe we can make just as good welds on the average with electric on cast iron, as with gas.

Mr. Petry brought out in some of his statements also the fact that the carbon will reduce approximately thirty points in the weld. I disagree somewhat with that, having before me a number of physical and chemical analyses; and we find that we can and frequently do reduce considerably more than thirty points. We have reduced possibly ninety points, and without proper care and even with extreme care we can't retain it. I would like to hear from some of the welders present as to how they maintain, for instance, a given carbon. If we start out and say we want to finish with a .10 carbon and probably .40 manganese, what material will we use to make that weld? I mean the carbon and manganese, of course. Other elements will have to correspond, more or less silica and sulphur within the limits of what would be required to make a good weld. I should like to hear from anyone who can answer that. If Mr. Petry can do it I should like to hear from him.

Mr. Petry mentioned—I don't know whether I understood him right or not—that special rods should be used for a.c. welding. I would like to have him go into that a little further. I didn't understand that it required special rods. The fact of the matter is we do practically all of our welding with a.c. at the present time, with the exception of a few things. There is a range, we find, in which you can work with a.c.; below or above it is difficult. I am speaking of twenty-five cycle. With sixty cycle it might change that range. I believe, however, there would still be a range. We find that we get better results than with d.c. within that range and we do not attempt to use a special rod. We use exactly the same rod for a.c. as for d.c. It makes no difference at all. But if a special rod is required we can possibly improve our results.

On the thermit weld, that was shown on the pinion, I would like to ask Mr. Petry how that weld would correspond in wear to an electric weld made on the same job if material had been put on electrically as compared with the thermit. I am assuming, of course, that the material would have to meet the range of the electrical conditions.

Regarding the physical tests which were shown, I would like to ask also if Mr. Petry will explain what angles were used on those welds—the "V" angles—the distance apart the pieces were set in making the weld. It was not shown on the screen and it is certainly a matter that requires considerable attention as the average welder knows. Various angles and the distances apart will materially change the physical constituents and conditions. The weld will fail by twenty-five per cent, thirty per cent or possibly more in the machine by different angles and expansion of the metal. Also in that connection, what is the approximate analysis or trade name, of material used in making the welds?

Further, what did the samples actually pull as a percentage, or pounds per square inch—whatever the basis may be.

I am sorry that Mr. Petry didn't say something about nickel steel (although he did mention it) in more details in his paper. I should like to have something on nickel steel. I heard a good deal about it not long ago and I thought we had the solution of a normal weld such as Mr. Petry showed, where

we could not reinforce. Most all welds can be made equal to the strength of the material, or more, if you can reinforce them; but where you cannot reinforce and where it must be a butt weld such as a boiler plate or tank plate, where you cannot lap it, then you want to get as near the standard strength as possible, or the strength of the plate.

Now we tried some time ago using nickel steel—approximately three and one-half per cent, with about .23 carbon and .70 manganese. The manganese was a little higher than we wanted. Possibly that was the reason we got poor results. But our nickel steel welds, after making a physical test of probably a dozen, would not stand as good as an ordinary weld would stand with Swedish iron or Armco iron, or any other ordinary steel rod we wanted to use.

Now I don't know whether we didn't know how to apply it or whether our analysis was off in the original rod, or where the trouble as, but our tests show that we could only get 67 per cent of the original sample, the standard, and it varied from there down as low as 60 per cent and 63 per cent. That was electric. In each case the test broke the weld.

A. F. Davis: I have not much to say, but there is one point I should like to emphasize. The trouble in electric welding and in other kinds of welding, which has been experienced, has been due almost entirely to the lack of properly maintaining the welding department. It has been the common practice in too many cases to merely allow the welding department to run along itself. To make a success of electric welding in a steel mill or any other industry, or, in fact, any kind of welding, a department should be formed with someone competent to handle that department at the head of it, making someone responsible for the results which are achieved in that department. Too many concerns, when they start in welding, depend entirely upon the experience of any operator which they may happen to pick up.

Now you will find good operators and bad ones. You will find operators that will do a job in one kind of a way and those who will do it in another kind of way, and the result is that you are not going to get satisfactory results unless you do adopt some kind of a standard practice. Some companies have gone into this a great deal and laid out standard methods of practice.

Take a machine shop. To get the best results there are standard ways of doing certain jobs, at certain speeds, and there is a certain kind of tool to use. The same kind of standard practice ought to be laid out for welding departments and if the same care and attention is given the welding department that is given other departments there would be a whole lot better results achieved.

There is just one other point. Mr. Petry made the statement that carbon arc welding (I don't recall the exact words) was only adapted to steel foundries for filling up blow holes, shrinkage cracks and things of that kind. It is true that the carbon arc process is the first one that was developed. The metal electrode came along then and it had so much greater ease of application on a wide variety of jobs that everybody forgot about the carbon arc process and jumped to metal electrode.

I believe there is a good deal in the carbon arc that has been overlooked and we have been spending a lot of time on the study of the carbon arc. We have gotten out a machine for carbon arc welding and with that process we have achieved better results that we have been able to achieve with metal arc process. That is with reference to tank work, longitudinal seams, welding heads in tanks and so forth. We find we can get better results in the weld and get a weld which is more ductile and one which will give us a greater tensile strength. We are also able to get tremendously greater speeds. We get out as high as forty or fifty foot an hour in quarter inch plate which is a physical impossibility to do with metal electrodes. I believe that a great deal of work can be done in furtherance of electric arc welding in the study of the carbon arc process as well as the metal electrode process.

A. D. Fishel: One of the interesting statements that Mr. Petry brought out, was on the classes or divisions that were best suited for the three general methods of welding that he described. There is no question but that each one of the three classes has its field, though these fields overlap in many applications. Naturally there is quite a difference, both in opinion and practice, as to what can be done most advantageously with electric arc welding.

One statement of a general character, that I think will hold, is that wherever a weld can be effectively made either by the electric arc or by the gas welding process, the electric arc method will be found to be lower in cost. This will apply to ninety or ninety-five per cent of the steel mill cases.

Mr. Davis emphasized the necessity of having a proper welding department. That brings to mind the comparison that I have heard, between electric arc welding and cooking. In this analogy, the welding machine is comparable to the stove, the welding operator to the chef, and the electrode to, say, a beefsteak. Now with a good beefsteak, a reliable stove and a capable chef, the chances are all in favor of your having a good dinner. If one of these factors, however, is not good, then the chances of goods results are proportionately decreased. If all three of these in welding are good, the chances are all in favor of good uniform welding. You may overcome the handicap of having poor or inadequate machinery or electrodes or a welder who doesn't know as much as he should, but if you can get all three of these things right then you can always get uniform and satisfactory welds.

About relative costs; Mr. Petry mentioned that with the decreasing cost of gas, gas welding would naturally step further forward. The cost of electric arc welding, however, has also been going down materially during the past two or three years. That has been especially helped by the development of welding with the a.c. arc, to which Mr. Cronk referred. Developments in equipment for that work are lowering the cost of arc welding, especially in the steel industry; because the initial cost of the equipment has been lowered with the transformer construction, while maintenance costs of static equipment are very low and operating costs lower due to higher electrical efficiency. So I think the electric arc will keep up the pace with the decreasing cost of the gas and the field for both become broader.

Another application of the electric arc, that while not directly on the subject of Mr. Petry's paper, is closely akin, is the use of the arc, in the steel mill, for cutting. That has grown rapidly during the past two or three years, helped along by the developments in the a.c. arc work. Cutting with the arc has a great many applications in the steel mill. Wherever electric arc cutting can be used, it is usually very much cheaper than gas. As in welding, there are some kinds of cutting where gas is to be preferred. In steel mill service, the ruggedness of the equipment is, naturally, a very important item. In the heavy current outfits necessary for efficient arc cutting, the development of transformer type cutting outfits, has marked a step forward; because, you can get more rugged equipment with a static machine, than with one having rotating parts, and you can also get high efficiency and relatively low maintenance cost.

On the subject of welding alloy steels, by electric arc instead of gas; there has been a marked advance during the past couple of years in the electric arc welding of special steels due to the progress made in the use of flux coated metallic electrodes. By using electrodes that are properly coated, the desirable characteristics of the steel can be more effectively put into the weld. The coating should be as light as practical, just sufficient to form a gaseous envelope around the arc and keep down oxidation and vitrification from the air and a little as a flux or cleanser and hastener of the drossing action but

yet not so much as to require chipping or brushing of the weld. Flux coated electrodes are now available and being used for practically every variety of alloy steel work. For example, some of the welding of the highest grade tool steel parts used in the automobile industry is being done with electrodes of alloy steel, coated in that way.

I want to comment on a point about a.c. arc welding brought up by Mr. Cronk. A.c. arc welding, if provided with modern transformer type of equipment which has means for properly sustaining and controlling the arc, does not require special electrodes over any range in which arc welding can be done. Naturally, better electrodes such as the flux coated types are more satisfactory with a.c. just about as they are with d.c., but bare electrodes can be used with a.c. arc equipment of the right type, just as with d.c. Further, the range of work with the present type of a.c. arc welding equipment is just as large for any commercial frequency as with d.c.

S. L. Henderson: I don't think I have anything to add to the discusion. I was interested in one of Mr. Cronk's questions about the welding of nickel steel. We find that in our plants we have some nickel steel to contend with and very often it is a case of building up nickel steel. Therefore, I should like to hear something on that point.

Carl H. Davis: Gentlemen, starting a weld is like building a house. You never put the roof on first. Be sure that you get the bottom first in putting in your weld. A great many welders will make a nice looking job on top, and when they get through they work their cloths around so that it looks nice, but they never pay any attention to the bottom. You walk around and watch them and you will see the lumps —up and down. Now a weld like that will never stand the tests. So always start at the bottom and build up, even if you leave it rough on top. That can be ground off or machined.

Now a great many people make a mistake in securing welders. They want a man to cut and they want a man to acetylene weld, and they want a man to electric weld. I do not believe that a man can do all those. I have seen acetylene cutters and had charge of them during the war. Those fellows used to cut along, using eight or ten bottles a day, and average four and five hundred inches out of the bottles. They had to do it. Then I might run short and go down for a welder, and it would keep him hustling to get out two hundred and fifty. That welder was a good welder but there is a different movement in different work. A man who cuts should be awfully steady. He learns to move his body and not his arm, and he can cut twice as fast that way. An electric welder has still another movement. A metallic welder has to move along slow and steadily if he wants to make a good weld.

You will find out that you will get better results if you have one man for each one of these things.

Another thing is, buy good equipment and keep it in good shape. Don't allow your torches and regulators to leak. It is dangerous and it is wasteful to gases. It runs the cost of your welding up a whole lot more.

Mr. Dyer: I should like to ask Mr. Cronk a question. On this cast iron welding with electric arc, what electrode do you use—cast iron filler or steel filler?

H. C. Cronk: Cast iron, normally.

Mr. Dyer: Do you flux it—or do you use the same amount as in gas welding?

H. C. Cronk: The same amount as in gas welding.

Mr. Dyer: On the electric arc, I have noticed that almost universally on a.c. machines the rods are fluxed and almost universally on d.c. machines they are not fluxed. I would like to ask some of the men who know, if the flux has anything to do with the ease of manipulation of the arc. I have had this experience: I have tried to draw an arc on a bare electrode with the a.c. machine and it is a good deal more difficult than it is to draw the arc on a coated electrode. Is there and difference in the case of manipulation on the a.c. machine between the bare electrode and the coated?

(Several of the members said "No.")

On the question of welding with alloy steel rods as applied to gas welding, I have had some experience and particularly within the last year. We find that if we take a nickel steel rod of approximately the analysis you gave, that we can get a very high tensile strength weld, Mr. Cronk, and we have also used ninety machine rods where high tensile strength was needed without increase in the strength of the metal.

W. Petry: I am sure that the discussion Mr. Cronk started, and that several other men helped out in, only proves the point that I brought out in one of my paragraphs, that it is impossible for one man to get all the information on this subject. He very possibly has had some information on a.c. arc welding that I have not had, or possibly has gone into it a little more in detail.

However, I want to say that in cast iron welding, when the cast iron passes through the high temperature of the electric arc, which is about 9,400 degree Fahrenheit (5,200 deg. Centigrade), the carbon that is in that cast iron, usually two per cent or greater, is greatly affected by that extremely high temperature. You will find by analysis that the carbon drops to a very great extent. In fact, it has been found that steel electrodes will give practically as high a tensile strength weld in cast iron as will cast iron electrodes, and where the contraction and expansion can be cared for in heating, they will give even greater tensile strength.

The line of weld, as I have shown in one of my microphotographs, in cast iron, will show the brittle character of cast iron welds to a very marked extent, and by etching we can trace that line very distinctly all the way along the weld, and investigating still further by making tensile strength tests we can get definite information on the strength of the weld.

A careful study of the fracture, by pulling the weld apart and showing the exact structure of crystals, and analyzing or studying the weld under the microscope, shows the structure of the grains and composition of them. It can also be proven through other research work that that structure is a lot more brittle and will not stand the strain that the original cast iron structure does. However, in many cases where that brittle structure can be well cared for, the electric weld will stand the strain on account of its stiffness and will make a patch job. But where it must come up to the specifications in size and shape of the original member, it has been my experience that it will not have the tensile strength of either cast iron or steel.

Now just a little remark further on this depreciation of carbon in a steel weld, by using a steel electrode. I have possibly made a pretty broad statement there. I didn't want to go into detail any more on it, or I would probably have modified my statement to some extent. I have found that a .30 carbon reduces practically to no carbon while passing through the arc. But the carbon can be held up to some extent by a real short arc. It is possible that a.c. will hold the carbon content a little higher than will d.c. because an ordinary operator will draw a slightly longer arc in d.c. than in a.c. welding, which of course is detrimental. A long arc should never be used. The shorter arc, as long as it still gets the maximum heat, is the proper practice.

I have found, with varying results, that a high carbon rod such as 1.10 per cent will drop through the arc to approximately .80, if the arc is maintained at a very short length. Of course, there is a lot of research work to be done on that and tests vary in wide range. You might make one test with one operator and get that result and another operator might give you thirty points below that. The weld itself will show, taking a foot length, a difference in analysis in the carbon content, of from five to forty points.

We can add carbon to a rod that has no carbon at all; or build up the carbon content. Take a .90 carbon rod for

(Continued on page 50)

WELDING AND CUTTING APPARATUS

MANY a weld takes all the skill in a man's fingers and all the brains in his head. When he is welding a broken aluminum crank case, for instance—what he wants to concentrate on is the heat-diffusion, alignment, temperature of his metal, the oxide, and so on—*the weld itself!*

He wants to *forget the torch*, as a sculptor forgets his chisel!

Before the REGO was perfected, this was impossible. Simply because, very often, the torch required nearly as much attention as the weld itself—to the detriment of the welding art.

Now you can forget the torch when you weld with a REGO.

The explanation: the REGO flame is made by oxygen and acetylene, mixed in the tip, under *low, balanced pressure.*

The REGO flame is neutral, smooth, steady—it will not flash back. Plunge the REGO tip into molten metal, press it tight against fire-brick—still it will not flash. The one torch for close quarters! It will not oxidize, carbonize, or blow the metal.

When you weld with a REGO, you can put your whole thought and skill on the weld itself—you can forget the torch.

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WELDING AND CUTTING APPARATUS

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Welding—Cutting—Brazing—Lead Burning—Radiator Soldering—Decarbonizing

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The "LITTLE SIX" OUTFIT is a special assortment of STANDARD REGO HIGH QUALITY EQUIPMENT.

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1 REGO MT torch
3 one piece copper welding tips, Nos. 1, 3 and 5.
1 Cutting tip and tip nut.
1 Special lead welding and radiator tip.
1 Decarbonizing torch (separate and complete).
1 Single gauge oxygen regulator.
1 Single gauge acetylene regulator.
10 Ft. corrugated oxygen hose.
10 Ft. corrugated acetylene hose.
2 Wrenches.
1 Spark lighter.
1 Pair spectacles.
1 Instruction book (Dunham's Automobile Welding).
1 Carrying case.

The "LITTLE SIX" outfit is so called because the man who owns one can perform the six most important types of repair jobs, namely:

1. Welding up to 1 in. thickness.
2. Cutting up to 1 in. thickness.
3. Brazing.
4. Battery repair.
5. Radiator repair.
6. Decarbonizing.

This complete REGO QUALITY outfit with an instruction book that tells you how, all packed in a handy carrying case, is the little outfit you have been waiting for.

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THE DECARBONIZING PROCESS

By B. Heyman

UNLIKE welding, cutting, and other oxy-acetylene appliances, which are designed and constructed according to numerous theories, decarbonizing apparatus is based on one simple theory. Although built in a variety of styles and shapes, the design depends on the fundamental principle upon which the decarbonizing process hinges, namely, the fact that oxygen and carbon unite very readily under the influence of heat. Therefore, the elements of design are concentrated in a few limited considerations:

1°: a means for insuring a constant flow of oxygen.
2°: a means for introducing the oxygen jet into the automobile cylinder.
3°: a means for controlling the flow of oxygen (quickly starting and stopping the flow).

These conditions have offered no obstacles in construction so that the present types of apparatus are eminently satisfactory for the service to which they are put. The original source of heat, however, must be effected by some external agency. Matches are the simplest means for beginning the reaction, although it is not improbable that at some time an automatic arrangement operating with the controlling valve will afford the necessary ignition. This will not only result in economy of time but will eliminate an exceedingly distasteful stage of the present methods of cleaning automobile cylinders. In conjunction with the igniting agent, a few drops of kerosene in the compression chamber or even a preliminary injection of oxygen will hasten the reaction. When such measures are employed, the operator must be careful of the resultant flareback.

The efficiency of removal of the carbon depends upon several factors. These are mainly:

1°: the skill of the operator.
2°: the volume and rate of flow of oxygen.
3°: the condition of the carbon deposit.
4°: the routine attending application of the process.

During the few years that the decarbonizing process became popular the apparatus was scattered over a wide range, embracing garages, repair shops, service stations, etc. Generally the outfit was installed by a manufacturer's service man, and a simple demonstration sufficed to produce proficient operators. It is, therefore, not unusual to find shops where every employee can perform the process most satisfactorily.

On the other hand, when a service man was not available, printed instructions were the means for educating operators. It would be difficult to state whether failure to have the service man's aid has tended to turn out less skilful operators. No matter what method was used experience was required in manipulating the torch, and in adjusting and controlling the oxygen supply.

Certain well formulated rules had to be followed. The manufacturer pointed out the hazards attending the process and also showed how to eliminate all danger. From the rules which were outlined either by the service man or in printed instructions no deviation was expected.

Therefore, when the manufacturer so explicitly pointed out the routine for cleaning each cylinder, the ordinary operator would surmise that no digression was permissible. It was understood that the piston had to be at dead center with both valves closed. This was clear enough, but no method was pointed out for determining the point where compression had ended, when both valves would be closed and the piston would be at the top of its stroke. Usually, the operator's ingenuity resulted in the use of a flexible wire which might or might not locate the piston at the highest position, but, there was no way of saying whether the valves were closed or not.

Actually, there is no need for the use of the flexible wire, nor for any assumption as to the condition of the valves. It is specifically stated that the "piston must be at the end of compression." This entails the condition that both valves are closed. Placing the thumb over the exhaust cock of the cylinder while the crank is being turned, identifies the correct position of the piston very easily. Furthermore, by relying on the firing order of the particular engine, it is possible to decarbonize the engine with one setting of any piston, relying on the position of the crank for setting all pistons after the first.

Considering a four cylinder engine firing in the order 1-3-4-2 it is readily seen from the diagram that during two full revolutions of the crankshaft all four cylinders fire. Therefore if the piston of any particular cylinder is set at the end of compression the next cylinder in the firing order can be prepared for decarbonizing by turning the crank exactly one-half a revolution. It is safe to assume that the logical way would be to start with the first cylinder. If, however, the operator should start with any other cylinder, No. 4 for example, the next cylinder would be No. 2 and the complete cycle would be 4-2-1-3. In any case, exactly one-half a revolution of the crank brings the next cylinder into the proper condition for the reaction.

Firing orders of various engines are usually to be found on the engine valve plate unless the plate happens to be so well covered with oil and grease that the numbers cannot be distinguished.

It must be remembered that two complete revolutions are required to complete a cycle for any cylinder, this including admission, compression, firing, and exhausting. In the case of a 4 cylinder engine it is necessary to turn the crank one-half a revolution to bring the next cylinder of the engine into the condition requisite for cleaning. For engines of a greater number of cylinders the proper turn for the crank is:

6 cylinder—1/3 revolution
8 cylinder—1/4 revolution
12 cylinder—1/6 revolution

It has already been outlined that the efficiency of removal of carbon depends on certain factors. The human factor does not enter into this type of work to the extent that it does in welding and cutting operations, and almost any mechanic can perform this duty most successfully.

The condition of the carbon deposits is one which depends entirely on influences which were fully discussed in an earlier issue of *The Welding Engineer*. But, regardless of the thickness or compactness of the deposit, the rate of flow of oxygen can be so adjusted that the removal will proceed at a very high rate of speed. Loss of oxygen must be guarded against by the use of port plug bushings, although the opening must not be so closed that the gaseous products cannot escape.

It is, therefore, safe to assume that the greatest economy can be effected only by curtailing all the routine attending the actual injection of oxygen. This not only refers to the procedure of setting the pistons, but also takes into account the removal of spark plugs, wires, and protection of the car. It is needless to go into details regarding these items as they can best be left to the individual.

The process offers very little for improvement excepting a certain few elements which have already been pointed out, but in the method of applying the process every operator can curtail his labor item to his own or employer's advantage by applying the procedure explained in preceding paragraphs.

AN EARLY ROTARY ELECTRICAL CONVERTER

Hermann Lemp,* who has been a prolific inventor in the electrical field narrates that he first heard the name of Edison in his native Switzerland, while experimenting with a phonograph in a factory at Neuchatel. At the first International Electrical Exhibition in Paris, in 1881, he saw Edison's first steam-driven dynamo and its hundreds of incandescent lamps. Although but nineteen years of age, he decided to go to the country where such wonderful progress was being made. Before the end of the year, he was at Menlo Park, on Edison's staff.

In 1887, Lemp joined the technical staff of the Thomson-Houston Electric Co. Professor Elihu Thomson and E. W. Rice asked him to devote all his time to the commercial development of electrical welding, which he did for seven years. The welding of electric street railway rails together in place led to the construction of a large rotary converter, probably the first one of magnitude. Now such machines for changing alternating electrical current to direct current, or vice versa, are common equipment in power stations and manufacturing plants. While working on the problem of providing alternating currents from a direct-current trolley wire, the "happy thought" which took form in a rotary converter, came to him like a flash.

Lemp's first plan for solving this problem was to couple a 500-volt direct-current motor to an alternating-current dynamo of 150 kilowatts capacity. While considering the size of the necessary apparatus, he came upon an article describing a novel electrical generator by Shuckert & Company, of Germany, which, engine-driven, had besides the usual commutator supplying direct current, slip rings from which alternating currents were collected. It occurred to Lemp that the engine was unnecessary, that the direct-current generator might be operated as a motor and that the alternating current could be taken from the slip rings. Since the company's welding transformers had been standardized on 50 cycles frequency and 350 volts, when the rotary converter was connected to a standard 500-volt trolley line, the alternating side gave 350 volts, suitable for the standard welders.

To try out the principle, a Thomson-Houston bipolar, direct-current motor of 500 volts was taken from stock; its armature was replaced by one of 250 volts, to increase speed and frequency; one of the commutator segments was grounded to the shaft, and the opposite segment was connected to a slip ring shrunk over a strip of mica laid on the commutator. The whole took about a day's time, and a standard welder when connected to this rotary converter operated perfectly.

This was an unusual engineering experience, to have two existing standard electrical systems co-ordinated by an intermediary without requiring all sorts of adapters, special transformers, and other apparatus.

The first welding train, built by the Johnson Company, of Johnstown, Pa., contained a 150-kilowatt rotary converter. Recently, Mr. Lemp learned that this original rail-welding equipment was still working in the streets of Lynn, Mass., after having made 250,000 welds.

It is not pretended that this narrative records the genesis of the rotary converter. It simply relates how one engineer, without previous knowledge of the work of others, solved his problem in rail welding by making a machine of the rotary converter type.—"Research Narratives, Engineering Foundation."

REVISIONS OF INTERSTATE COMMERCE COMMISSION REGULATIONS

The Interstate Commerce Commission has ordered the following revisions in paragraphs 1861 (j) and (w), effective February 10, 1922:

1861 (j.) A cylinder must be condemned when it leaks or when the permanent expansion exceeds 10 per cent of the total expansion. Cylinders condemned on account of excessive permanent expansion may be further handled under the provisions of paragraph 1861 (x).

Cylinders Exposed to Action of Fire

1861 (w.) Cylinders which have been in a fire must not again be placed in service until they have been properly heat treated and retested as prescribed in paragraph 1861 (x); provided, that acetylene cylinders need not be heat treated if examination shows the porous filling to be unchanged and intact, and they may be used after passing the pressure test prescribed therefor.

It is further ordered that paragraph 1861 (x), as set forth below, be made a part of the Regulations, effective February 10, 1922:

1861 (x.) The reheat treatment of cylinders must be followed by retest and these operations must be carried out, supervised, and reported, as prescribed for the original heat treatment and test by the specification covering the manufacture of the type of cylinders in question. In the case of cylinders of outside diameter exceeding 4 inches, a permanent expansion of not less than 3 per cent or more than 10 per cent of the total expansion must be shown in the retest; provided, that if the cylinders can be segregated into lots having practically the same chemical composition, the allowable permanent expansion in the retest may be from zero to 10 per cent of the total expansion if one cylinder out of each such lot of 100 cylinders or less is subjected to and passes the requirements of the flattening and physical tests as specified by the specification for the manufacture of the type of cylinder in question.

BIG PISTON REPAIRED BY WELDING

The accompanying illustration shows a 2,800 lb. cast iron piston of a Diesel engine after completion of a repair by oxy-acetylene welding. The piston was cracked across the head in the form of an X, and is one of a series of 30 pistons which were damaged in a similar manner. In preparing the piston for welding, a cutting torch was used to cut out a deep chamfer at the best angle for making the weld. Approximately 75 gallons of coal oil were used in preheating the casting, 105 lbs. of cast iron rods were used as filler, 6 cylinders of oxygen and 3 tanks of acetylene were consumed, and the work required 35 hours.

A 2,800 Lb. Diesel Engine Piston Reclaimed by Acetylene Welding.

The repair of the piston shown was so satisfactory that it was decided to weld the entire series of 30 pistons. The work was done by the R. E. Parrish Welding Shop of Iola, Kansas, for the Lehigh Portland Cement Co.

WELDING IN THE OIL FIELDS

Adoption of Welded Joints as Standard for New Pipe Line Construction—How Gangs Are Organized for the Work

IT may be doubted if there is any stride in the progress of the oil industry that has been taken with greater caution than the advance that is now definitely accomplished in the construction of oil transmission pipe lines. Some years ago when welding was first coming into general public attention and before the development of sound practice in dealing with some of the knotty problems that were bound to arise, oil men attempted to construct welded lines. It was only natural that they met with serious discouragement in the failure of early work of this kind and the effect was to throw welding generally into disfavor among oil men. In fact, for a considerable time it was not possible to interest them at all in welded lines.

However, welding and cutting progressed so steadily and conspicuously in other industries that the oil companies were bound sooner or later to give the process another trial, and very naturally better results were obtained, owing to the more mature understanding of the process. Oil men in localities where work was being carried out by competent welders soon learned that lines could not only be constructed more cheaply with welded joints than with screwed joints, but that the joints could be made so sound that they were really superior in every respect to joints made by the old methods. Still there was the disposition to let the other fellow do the pioneering and it is only within very recent years, almost within months, that there has been any general tendency toward the adoption of welding in oil pipe line construction.

One of the first pipe line companies to experiment with welding was the Prairie Pipe Line Company, of Independence, Kansas. This company bore the brunt of some of the early failures and for very many years would have nothing whatever to do with welding. It is all the more interesting for this reason to learn that the same company was one of the first to resume experimental work and to finally adopt welding as a standard method of construction for new lines.

The first fifteen miles of 8 inch welded line was laid by the Prairie Pipe Line Company less than two years ago. This company used a 100-lb. portable acetylene generator and worked with five or six welders tying together one-half dozen or more lengths of pipe at each sitting. The welding crew was advanced as rapidly as the work progressed, keeping close on the heels of the lining-up gang going ahead. Two or three operators trailed the main welding crew, tying in the long sections, the last welder working in a bell hole to tie in the still longer sections when they were rolled into the trench. On this line the company used plain pipe with 60 degree bevels at the ends. The line traversed much difficult country in a district that is rough and hilly. After the work was thoroughly organized the crew advanced at about the rate of one half mile per day. The total crew comprised eight welders and about twenty-five extra men to line up the pipe and assist in making bends and getting the slack in the welded line. When completed there were 4,250 welds.

The line was subjected to a cold water test under a pressure of 775 to 800 lbs. and it was found that there were two small leaks in the line. When these were repaired, and the pressure was run up again, the line was found to be in good condition, and it was at once placed in service for the transmission of oil. This was in February, 1921. Up to the present time none of the joints has given the slightest trouble, and as a consequence, the Prairie Company's superintendent decided to adopt the welded line as a standard for new construction. Since welded construction was recognized by the Prairie people there have been no breaks in welds, the lines have been free from collar leaks and there has been no oil loss whatever.

It should not be assured, however, that the Prairie Company in their later pipe line construction followed closely the construction-methods pursued in their initial welded line. On the contrary, they made a number of material changes which resulted in greater efficiency and greater economy. One of the principal changes was in the length of the original pipe sections. By making a special arrangement it was found that the mill would supply 8-inch pipe in 40 ft. lengths with the ends beveled to 45 degrees for welding, which made it possible to advance at the rate of slightly more than a half mile a day, with only six welders. The force of helpers on the second 15 miles of pipe line was about the same as on the first 15 miles. The second line, which was laid near Shawnee, Okla., was finished without a single leak showing in the welds, but there were a couple of joints that had to be removed and replaced because of pipe sections that were imperfect as manufactured and delivered. These two 15 mile stretches of 8-inch pipe line and 6 miles of 6-inch line have given remarkable satisfaction, no leaks having developed in any of the lines after the repairs noted following the pressure impact tests on the fist 8-inch line.

The Prairie Pipe Line people have found oxy-acetylene welding and cutting very useful in the repair of pipe lines in which there has been more or less severe pitting of certain sections. Where the lines cross districts impregnated with alkali, pitting has been found to be so serious that after a few years entire sections of pipe have to be taken up and replaced. The cutting torch has been found to be invaluable for taking out bad sections and oxy-acetylene welding has made it possible to insert the new pipe sections with a minimum of expense and delay. Only last summer, the Prairie Company made repairs of this kind on an 8-inch line between the company's Cobb and Argo stations, a distance of about 35 miles. The first step was to displace the oil with water, after which it was a simple matter to remove the bad sections. In some places, it was necessary to remove only two or three consecutive sections, while in other places, as many as 20 sections had to be taken out. New sections were welded while the gang was lifting the damaged pipe, and as soon as the pitted sections were taken out the replacement was ready for tying in. In was simply a matter of cutting the old line, throwing out the old pipe, getting the proper slack into the new line and welding it in place. This method of replacing pitted pipe requires only a small gang and does not require the use of flanged right and left nipples which are essential in screwed lines.

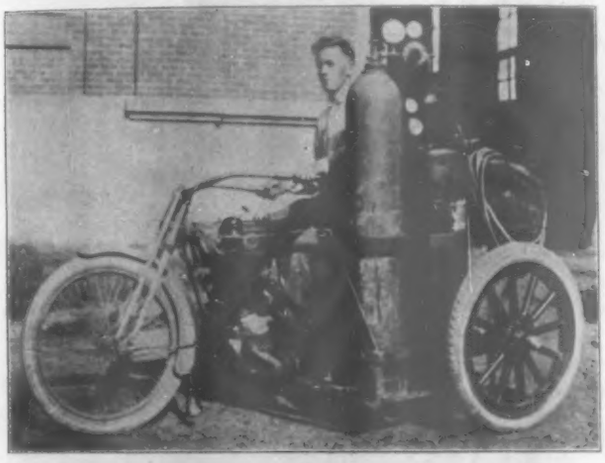
In speaking of welded lines, Mr. N. E. Wagner, the Prairie Company's welding superintendent in Oklahoma and Texas, says, "There is nothing in connection with welded joints to affect the pumping pressure. Our scrapers have gone through welded lines in better time than through screwed lines. Moreover, we have had no trouble whatever in regard to leaks developing once the line is placed in operation. We place the slack in the welded lines the same as we do in screwed lines. The principal thing to consider in putting in welded lines is to use only first-class welding equipment. The next thing to consider is the welder. We put all our welders to test and if they cannot show good workmanship we do not hesitate to

tell them we cannot use them, because both the equipment and the welders have to be A-1."

Mr. Wagner has spoken out of the fullness of his experience with reference to the character of equipment and welders required for oil pipe line work. The Prairie Company has just completed under his direction 140 miles of 8-in. pipe line from Mexia, Texas, to Hensley. On this line 40 ft. lengths of pipe were used. There were four gangs working at one time, one starting from each end and working toward the center, and two starting at the center and working toward the ends. This was a rush job. Two 190-lb. portable acetylene generators, 4 welders, working from each generator and 3 welders tying up the line behind, with acetylene tanks on carts, were assigned to each gang. With this organization in full operation it was possible to lay a mile per day per gang or 4 miles per day with all 4 gangs going.

A FEW PUTT-PUTTS TAKE THIS UNIQUE OUTFIT TO THE JOB

While strange and divers uses have been made of the motorcycle as a means of transportation, it remained for an electric company of new Orleans, La., to recently evolve the unique scheme of using it for the transportation of a gas



A Speedy Means Used for Transporting the Gas Welding Outfit By One Welder.

welding apparatus. Confronted with the problem of finding a means of conveyance that would be at once quick, efficient, and economical for transporting the welding outfit to any place on the property where it might be needed, this company finally bought a second-hand motorcycle, fitted it with a third wheel and a side frame and stored the tanks therein. Now when there is any welding to be done this outfit is called into use.

ANOTHER AMATEUR CRACKSMAN
(A Letter from Kut-off)

Dear Editor:

Maybe you've been reading in the paper the way I have how burglars has been taking to burning open safes and robbing places that way. It sure sounds possible and whenever I see anything in the paper telling about such a case I always read it. But I guess half the time the stories are faked because you can't cut open a safe as easy as the papers make you think you can. Leastways I found I couldn't a couple of weeks ago when I tried it. You know how these Prohibition people passed a law about liquor and beer? Who'd ever thought things would come to pass in this here country when a fellow would have to be satisfied with Adam's Ale after finishing a day's work. I remember when I first started to work for Bill we'd send around the corner for a big pail of suds and it only cost a dime, and maybe it didn't taste sweet after a tough job over a hot fire. At any rate those days are past and now when you've got a bottle or two you hide it in a big safe and put a watchman outside and maybe some burglar alarms around the place to protect it from the watchman. It ain't safe to have the stuff any more than diamonds. And if you have plenty and want to get rid of some, it's curtains and the exit march. About a million revenue men get on your trail until they've cornered you and had you up for every crime imaginable. And if you carry it on your hip you're sure to have some liquor hound smell it out and then you get nabbed too. There ain't no place safe unless it's in some other country but who wants to leave the good old U. S. A. even though the Pros have got us tackled and down. At any rate some fellows is coining money making the stuff and selling it, while others who have the pull get the stuff from some place and believe me they are getting rich. And in the meantime the people are paying to catch them and getting poor between paying for trying to catch them which don't happen any too often and between trying to catch some stuff which the last is more expensive, and besides mostly you get stung, and you can't say anything because you are liable too. But one fellow has been going it strong until the dry agents get wind of him and trail him until they have some evidence, but the real proof is hard to get. Then one day the fellow wises up that somebody is red hot after him and he skips almost the same time as the drys make a raid on his office. They don't catch him, seeing as he's gone but they catch a clerk and they make him think he'll be sent away and maybe hung which they can't only they want to find out all he knows which ain't much at that. But he says all the papers what they need is in a big safe in the next room, only he can't open it seeing as the boss was the only one what had the combination and he's gone. Well, they call in one of these experts from a big safe company and he fools around a while and then he says something is wrong and that they'll have to open the safe some other way. He says maybe it can be cut open and he mentions Bill. You see that's how I happened to be there. Bill was busy that day on a special job and he told me to go up there and cut open the safe, so I went and took the torch and started out. When I got there I rigged up the stuff and started to cut but I couldn't get the cut going. All the fellows tried to tell me what to do and one fellow says maybe my flame isn't strong enough and I think so too, so I put on as much pressure as I can get and try to cut. Once in a while a place would melt until I had a little hole started but only part way through. I can see the stuff ain't steel, but so long as I'm here and the job is paying good money and all expenses what comes from the government why should I give up and I keep on trying to melt a little at a time until all of a sudden I burn the end of my tip and the torch begins to backfire like a machine gun which scares everybody so bad thinking maybe there's an explosion that they all run and leave me alone. I can't use my torch seeing as the only tip is burnt up, so I starts to figure out what to do and then I think maybe I can melt out a piece with a welding torch, so I go to the shop and pick out a torch to take back and a big size tip, when Bill comes in and wants to know if I'm finished. I tell him what happened and he looks me over for a while and then he grins and says if brains were dynamite maybe I couldn't even blow a peanut shell off my head. Why he says didn't you cut out the combination and put your fingers in and pull back the bolts? Those fellows don't care about the safe and the government won't have to pay for damage seeing as its a raid. So I go back and do as Bill says only I don't take the welding torch only taking a new cutting tip which does the job fine.

Yours,

Kut-off.

AIR REDUCTION CO. ACQUIRES D-B

A Consolidation Which Brings Together Two Important Organizations in the Oxy-Acetylene Industry

ANNOUNCEMENT has been made by the Air Reduction Sales Company that it has acquired all the assets, including the patents, trade marks and trade names, of the Davis-Bournonville Company, of Jersey City, New Jersey.

Negotiations effecting this move were consummated on March 17, 1922. It is understood that the purchase was accomplished without the need of public financing or bank loans.

The consolidation brings together two large companies

Davis-Bournonville Jersey City Plant.

whose histories have been closely allied with the history of the development of the oxy-acetylene welding and cutting industry.

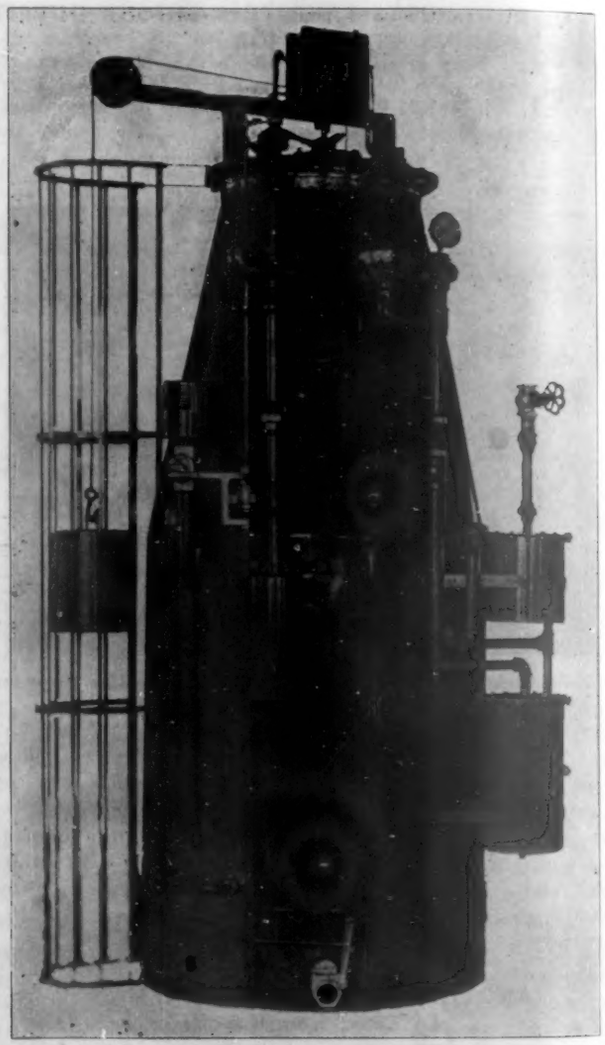
The Air Reduction Sales Company is one of the pioneers in the extraction of gases from the air for industrial use. Its principal product is oxygen, which is used to the greatest

A Mechanical Cutter in Operation.

extent, in conjunction with acetylene, in producing the high-temperature oxy-acetylene flame. The company owns and operates nineteen oxygen plants in important industrial centers of the country. Annually, these plants turn out hundreds of millions of cubic feet of oxygen, this gas being compressed in steel tanks and distributed, through the medium of a plant-and-warehouse service system to the country's railroads, shipyards, steel mills, manufactories, garages, scrap yards, repair shops, etc.

Acetylene ranks next to oxygen in importance in the list of Airco products. The Air Reduction Sales Company owns and operates ten plants devoted to the manufacture of this gas, these plants being distributed throughout the country in a manner that well complements the company's oxygen facilities.

In addition to its oxygen and acetylene producing facilities, Air Reduction owns a carbide plant, a welding and cutting equipment manufacturing plant, and extensive laboratories for the carrying on of useful research in connection with its various activities.



This Well Known Generator Has Been Re-christened "Airco-Davis-Bournonville."

The Davis-Bournonville Company was organized in 1907 by Augustine Davis, Eugene Bournonville and C. B. Wortham. Three years before, Mr. Bournonville had received the first oxy-acetylene torch to be introduced in the United States, this torch having been sent him by his associate, Edmond Fouché, of Paris, who, with Picard, had developed this revolutionary tool. The first Fouché torches, or blowpipes, as they were called, used the gases under high pressure, but Fouché later produced a low-pressure, or injector, type, employing the oxygen under high pressure and

the acetylene under low pressure. Subsequently, Gauthier and Ely, of Paris, brought out the positive-pressure, or medium-pressure blowpipe, in which both gases were used under moderate and independent pressures, affording positive control and maintenance of gas proportions.

Messrs. Davis and Bournonville obtained in 1907 rights for the "Gauthier-Ely" torch in the United States and Canada. The organization of the company followed, and from then on came a period of unremitting effort on the part of the Davis-Bournonville Company to develop and improve the original positive-pressure torch. As success was attained in connection with the welding torch, the company's activities were directed to the development of oxy-acetylene cutting torches, acetylene generators, and finally to an especially successful line of patented machines for welding and cutting as the use of the oxy-acetylene flame became general. These patented machines, by virtue of their labor-saving features, have already done much to revolutionize production methods and this despite the fact that the full possibilities of this type of equipment have only been slightly taken advantage of by modern industry.

The merging of the Davis-Bournonville Company with the Air Reduction Sales Company brings to the latter organization all of the products that have been developed by "D-B." These products include hand welding and cutting torches in a variety of styles and sizes, suitable for all classes of service; machine torches for welding and cutting; pressure regulators; lead-burning torches; carbon-burning outfits for use on motor-car cylinders; acetylene generators, in five sizes; 25, 50, 100, 200 and 300 lbs. capacity; tube-welding machines and tube-fabricating equipment; barrel-welding machines; weldographs for robe rails, milk cans, etc.; the radiagraph for straight-line and circle cutting of steel plates and forgings; the oxygraph in two styles for cutting forgings, dies and shapes; the camograph for production cutting of hand holes in steam-boiler headers, locomotive links and other parts made in quantity; the pyrograph for cutting boiler flanges to height and caulking angle in one operation.

It is the intention of the Air Reduction Sales Company to continue the manufacture of "D-B" torches, acetylene generators, special machines, etc., under the supervision of the men who developed this brand of oxy-acetylene apparatus. The equipment will be marketed under the trade name of "Airco-Davis-Bournonville" through the medium of the Davis-Bournonville service organization in combination with the service system that has been built up for the distribution of Airco oxygen, Airco acetylene, and other Airco products for welding and cutting.

COST OF THERMIT WELDS REDUCED BY DECREASING AMOUNT OF WELD METAL

As a result of an investigation by the Research Department of the Metal & Thermit Corporation, New York, to reduce the cost of thermit welding, it has been found that economies amounting to 10%, or over, can be made in regard to the amount of thermit required to make a weld.

It has been found that by reducing the size of the collars or re-inforcements of thermit steel, also by narrowing the gap and changing considerably the proportions of gates and risers, it is possible to weld the smaller sections, such as 2 in. x 3 in. up to 4 in. x 6 in. with very much less thermit than was ever believed possible before. For instance, a weld on a 2 in. x 3 in. section for which 40 lb. of railroad thermit used to be recommended, now can be made with only 10 lb. of thermit. On a 3 in. x 4 in. section, where 55 lb. was formerly recommended, 25 lb. only is needed, providing the size of collar, width of gap and size of the various gates are proportioned in accordance with the dimensions now found best.

On a 4 in. x 6 in. section the new method will give a perfect weld with a saving of over 10 per cent in the thermit required, i. e., while 75 lb. was previously recommended for this size of frame, the new method will weld it with only 65 lb. or a saving of 13⅓ per cent. On the smaller sections the saving runs up into high figures and enables a thermit weld to be made at a cost which will compare favorably with the cost of other welding methods.

The accompanying table gives the width of gap, width and thickness of collar, size of gates and quantity of thermit which should now be used in welding all sections from 3 in. x 2 in. in size up to 7 in. x 7 in.

Thermit Required for Welding Various Sections

Width of Frame Inches	Depth of Frame Inches	Width Gap	Width of Thermit Steel Collar Inches	Thickness of Thermit Steel Collar Center Inches	Heat. Gate Inches	*Pour Gate Inches	Riser Dia. Inches	Recommended Amount Inches
3	2	½	2½	½	1	1	1¼	10
3	2½	⅜	2¾	⅜	1	1	1¼	12
3	3	⅝	3	⅝	1	1	1½	16
3	3½	⅞	3¼	⅞	1	1	1½	20
3	4	¾	3½	¾	1	1	1½	25
4	4	⅞	4	⅞	1¼	1¼	2	40
4	4½	⅞	4	⅞	1¼	1¼	2	45
4	5	⅞	4	⅞	1¼	1¼	2	50
4	5½	1	4½	1	1¼	1¼	2	60
4	6	1	4½	1	1¼	1¼	2	65
4½	4½	1	4½	1	1¼	1¼	2¼	60
4½	5	1	4½	1	1¼	1¼	2¼	65
4½	5½	1⅛	5	1⅛	1¼	1¼	2¼	70
4½	6	1⅛	5	1⅛	1¼	1¼	2¼	75
5	5	1⅛	5	1⅛	1¼	1¼	2½	75
5	5½	1⅛	5	1⅛	1¼	1¼	2½	80
5	6	1¼	5½	1¼	1¼	1¼	2½	85
5	7	1¼	5½	1¼	1¼	1¼	2½	90
5½	5½	1¼	5½	1¼	1¼	1¼	2¾	85
5½	6	1¼	5½	1¼	1¼	1¼	2¾	90
5½	7	1¼	6	1¼	1½	1½	2¾	105
6	6	1¼	6	1¼	1½	1½	3	100
6	6½	1¼	6	1¼	1½	1½	3	115
6	7	1⅜	6½	1⅜	1½	1½	3	125
6½	6½	1⅜	6½	1⅜	1½	1½	3¼	130
6½	7	1⅜	6½	1⅜	1½	1½	3¼	140
6½	8	1⅜	7	1⅜	1½	1½	3¼	150
7	7	1⅜	7	1⅜	1½	1½	3½	150

*Diameters shown above for pouring gates are mean diameters. In practice these pouring gates should be tapered, bottom diameter being approximately ¼ inch less and top diameter approximately ¼ inch greater than dimensions given.

FIRST ANNUAL DINNER OF AMERICAN WELDING SOCIETY APRIL 26

A beefsteak dinner will be a feature of this year's annual meeting of the American Welding Society.

This event, which will be the first annual dinner to be held by the Society, will take place at Reisenweber's, 58th Street and Eighth Avenue, New York City, at 7 o'clock, Wednesday evening, April 26th. It will be solely a good-fellowship affair, with a lot of fun in between a maximum of good things to eat and a minimum of "speeches."

Every member of the A. W. S. is invited not only to attend this dinner himself, but to bring his friends as well. Out-of-town members attending the annual meeting should make a point of staying over for the party.

Tickets may be secured from the secretary of the association at six dollars per plate. Reservations should be in before April 12th.

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A Question of Training

EVERY time a boiler explosion occurs and inquiry reveals that a seam has been welded here, some well meaning person ventures to recommend that welding should not be allowed on such work "until further notice." If such a policy should be adopted generally, the welding art would never succeed in getting the recognition it deserves. The great need is not for restriction, but for training. There is still an urgent demand for good operators, preferably specialized operators. If boilers or similarly important structures are to be welded, the need is for men who are trained to work well and make perfect welds the first time, regardless of the time element. More welding failures are due to poor supervision in this respect than to any inherent defects of the welding processes.

Welding as a Salvage Tool

A TRIP through the average manufacturing plant will at some point lead past a pile of scrap which should not be scrap, especially if it is composed of metal parts. Defective castings, for example, which are rejected by assembling departments are not necessarily junk. In most cases the torch or the arc will fill up a blowhole, or build up a broken part, at a cost far below the cost of replacement. A case has been cited recently of one welder whose work was carefully checked for a long while in order to determine just how valuable his work was. The records showed that welding was effecting a saving of over a thousand dollars a month more than it cost the factory. Hundreds of factories in which welding is now considered only as a repair process might apply it to salvage work and get enough value to justify the installation of additional equipment.

It Is Better to Know Than to Be Caught Napping

PEOPLE are already beginning to talk about a business revival with real sincerity. It is here because a normal effort is being made to keep the wheels turning. Welding is sure to get its share of the benefits, and salesmen in the industry look forward hopefully to a prosperous year. It is a good time to take note of the fact that there are four welding processes, each one of them showing marked development each year. The wise salesman will take pains to become thoroughly posted on all four methods, their special applications, and their limitations. This is particularly true when the question of production welding is involved, for the buyer is apt to be well informed himself and will naturally have the greatest respect for the salesman who displays the most all around knowledge of welding processes.

Speed Is Not a Factor in Good Welding

WELDING is rapidly gaining in popularity as a subject for discussion in technical magazines and technical societies. Authors and speakers in their enthusiasm over successful applications, nearly always make reference to speed possibilities, and here a word of caution is due. The careful reader or listener will notice that speed records are usually qualified by admissions of inferior results. There is a limit to the desirability of speedy work because fast welding may not be good welding. It would be a fine idea to forget all about the time element for a while and think only in terms of perfect fusion and sound welds.

Our Moral Leadership in Jeopardy

OVERRIDING the earnest recommendations of the President, in defiance of the opinion of the Secretary of the Navy and of every qualified naval expert in the United States, the House of Representatives is proposing to cut the per-

Read on this page, from issue to issue, a description of the features which have made Prest-O-Lite a national institution

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DISSOLVED ACETYLENE

sonnel of the Navy to a point which will reduce this country to the world's third naval power instead of its first.

"Economy run mad" is the only phrase which can fitly characterize this attitude of Congress in respect to the Navy. The situation is filled with such ominous possibilities as to alarm every patriotic American. The facts in the case are so simple and so easily grasped that there should be no possibility of misconstruction:

Under the Four Power Treaty the famous 5-5-3 provision placed the United States and England on a par in regard to naval power with Japan a close second. But in order to keep that radio it was necessary that the United States should maintain a personnel of 130,000 men. Congress, having accepted the treaty, now proposes practically to scuttle it at the expense of the United States by cutting our Navy to one-half the necessary minimum or, in actual figures, to 2,000 men less than the number enlisted today in the Japanese navy.

The protests of the President and of his naval advisors have apparently fallen on deaf ears. Congress needs a rallying cry for the coming election, and the Navy is to be made the goat.

As representatives of the business interests of the country we are at least as fully awake to the urgent need for economy in our government as any politician in Washington. But when economy is strained to the point where the dignity, the power and the prestige of America are menaced it ceases to be a virtue.

The whole country rejoiced when the treaty for the limitation of armament was successfully negotiated, but no patriotic American ever dreamed that that treaty might be used as a weapon to undermine the proud position which the United States has won as the leader of the nations in the march of civilization. Yet that is precisely what Congress is doing today in the sacred name of vote-catching legislation.

Only men utterly ignorant of history and human nature waste time indulging in vain dreams that war has vanished from the earth. Sane and thoughtful men know that the threat of war hangs over the world as heavily today as it has ever done in the past and that the only real hope to avert that terrible disaster is in the power and influence of the great democratic nations, among whom the United States stands first and foremost. In fact, it is not too much to say that the equilibrium of civilization will depend for another generation at least on the influence for peace which America alone can exert.

To maintain that power and prestige which for a hundred years has never been exerted in an unrighteous cause it is vital that America should ever have behind her the one argument which is never misunderstood—adequate armed force.

Can anyone doubt the effect on the turbulent and half-civilized people of the Orient of the knowledge that the United States was inferior in naval power to Japan? We are no longer an isolated nation but a mighty world power, with far-flung possessions scattered over the seven seas. More than that, we have a moral leadership which has caused weaker peoples of the earth to look to us as a sure bulwark against oppression. In South America, in China and in Russia we have assumed moral obligations which, if need be, we must be prepared to uphold by force; and, if that need should ever become an actuality, that force must be exercised on the sea.

We believe that if the people of the United States thoroughly grasp the situation which now concerns us they will overwhelmingly support the President and the Secretary of the Navy in their demand that the United States be inferior to no power on earth in naval strength.

This is a question which far transcends any mere matter of dollars and cents. It is a question as to whether we are worthy to hold that world leadership which we have won.

CURRENT WELDING LITERATURE

DISCUSSION ON THE CYC ARC PROCESS OF AUTOMATIC ELECTRIC WELDING—The applications suggested for this new welding process were discussed at important British centers, these discussions being reported in in detail in the Journal of the Institution of Electrical Engineers, London, February, 192[illegible].

AUTOMATIC SEAM WELDING AND THE MANUFACTURE OF TUBES, by J. L. Anderson—A description of the machinery that has been perfected for the manufacture and forming of steel tubing.—Acetylene Journal, April.

CRANKSHAFT FORGING BY RADIAGRAPH, by Fred E. Rogers—Mechanically operated cutting torch is admirably suited to heavy crankshaft cutting, for preliminary cuts and cutting after cranks have been twisted through 120 degrees.—Canadian Welding Journal, March.

DAY OF THE SCRAP HEAP IS OVER, by F. A. McLean—Equipment which formerly would have been sold to the junk man most manufacturers repair today by autogenous welding.—Canadian Welding Journal, March.

WELDING WITH METHOD, by Marcel Piette—Two essential qualities of a perfect weld are mechanical strength and economy. The welder is urged to make no unnecessary motions, and not to disturb the metal unnecessarily, so that gas may not be wasted and the metal may not be harmfully affected.—Revue de la Soudure Autogene, February.

THE AUTOGENOUS WELDING OF COPPER, by Marcel Piette—The author points out that successful copper welding depends more on the method of execution than on the nature of the filler rod, cites some examples of good welding on this metal, and gives instructions for getting these results.—Revue de la Soudure Autogene, February.

WELDING OIL BARRELS SAFELY WITH THE OXY-ACETYLENE TORCH, by David Baxter—To avoid explosions when oil containers are to be welded it is recommended that they be filled with water while the welding is being done.—American Blacksmith, March.

THE MAKING OF JOINTS IN SEAMLESS STEEL TUBING, by C. N. Waterhouse—Description of a series of tests on the oxy-acetylene process applied to the tubular metal structure of aeroplanes.—Acetylene and Welding Journal, London, February.

THE DEPENDABILITY OF CAST IRON WELDING, by G. O. Carter—Preheating and annealing essential. Correct preparation of the casting. Some results obtained commercially. Any welder can be sure of his work if castings are completely preheated as regular practice.—Iron Age, April 6.

PATCHING ALUMINUM CRANK CASES

By G. E. Ward

A short time ago I read an account of one welder's method of patching aluminum crank cases, using a piece of iron to support the added metal. I have had very good success by using a thin piece of common iron, say 24-gauge, cut in the desired shape and placed under the place to be built up, then covering with a thin coating of plaster of Paris, making all seams tight around the edges. (We all know that adding any great amount of filler rod with the torch, in cases where large pieces are missing, is a slow and expensive job.) Now after the form is thoroughly dry, I bring the casting to the proper heat for welding, having already welded enough aluminum scrap in an iron ladle to fill the mold, then pour in the molten aluminum, adding a little more metal than seems necessary on account of shrinkage in cooling. After the metal is set, I weld around the edges and the job is done. I find this method very satisfactory where large parts are missing. It takes only one-fourth the time, saves gas, and gives a smoother job.

SUTTON WELDING PRODUCTS CO. OPENS IN INDIANAPOLIS

Mr. C. R. Sutton, formerly of the Sutton-Garten Co., has recently launched a contract welding and welding supply business to be known as the Sutton Welding Products Co., at 32 South Senate Avenue, Indianapolis, Ind. For the last nine years Mr. Sutton has devoted his time exclusively to the sale and use of oxy-acetylene welding and cutting equipment and supplies in Chicago and Indianapolis. This experience has brought him a thorough knowledge of the best practices and an appreciation of the needs of the industry.

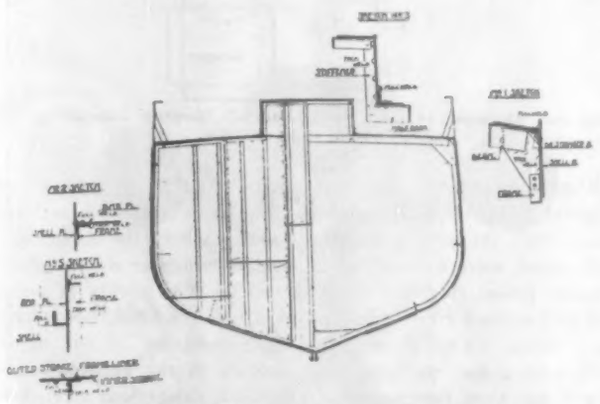
ARC WELDING IN SHIP CONSTRUCTION*

Trial Effort on Small Japanese Craft Proves Successful and Further Application Is Made on Steel Caisson

By M. Harmiishi

IN Japan, some years ago, Dr. K. Ito, of the Mitsubishi Dockyard and Engine Works, Nagasaki of the Mitsubishi Shipbuilding Co., Ltd., introduced and recommended the adoption of the Kjelberg's arc welding system to his works after he had seen it in operation in Sweden. Since then it has been used to some extent to repair cracks and blowholes in iron and steel castings at the Nagasaki Works and at the Hikoshima Dockyard of the same company of which I am manager.

I learned that in England, arc welding was being adopted and so much used that Lloyd's Register of Shipping had been under the necessity of issuing tentative rules for its use in the building of ships and was therefore led to give the subject further study, and resolved to try it on ship construction should the chance arise, even although our government



Details of Welds Made in the Frame of the "Dairyo Maru."

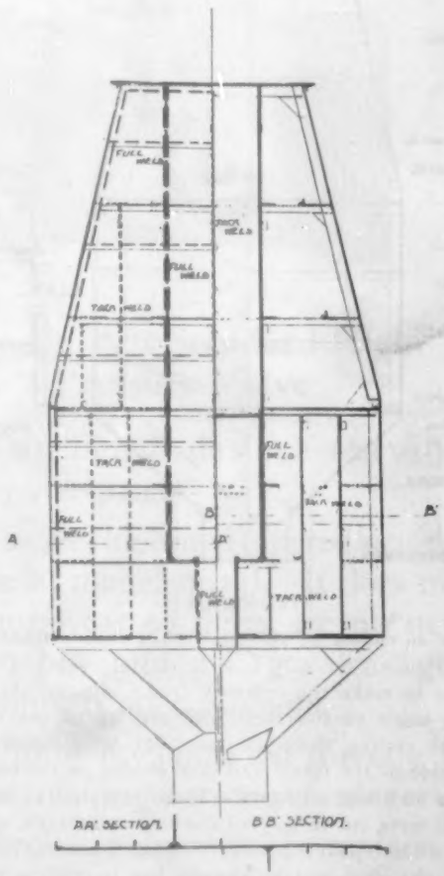
surveyors still declined to use it either on ship construction or even on ship repairing. For trial purposes, I considered it would be advisable to adopt it on a small craft, such as a barge or lighter, with which our surveyors would not have occasion to interfere. On looking out for such a job, I obtained an order at the end of last year to convert a steam trawler, the "Dairyo Maru," into an oil lighter, capable of carrying about 300 tons deadweight, and I secured the owner's sanction to do this job with electric arc welding as far as it could be suitably managed. The job was completed quite successfully by the arc welding process to her owner's entire satisfaction.

The next attempt was made on a steel self-floating caisson for the new dry dock of our Hikoshima Dockyard, known as our No. 2 Dock, 460 feet long. The caisson was designed by us, and constructed with arc welding very satisfactorily in the Hikoshima Dockyard, and is working very well without giving any trouble at all.

Details of these applications are given herewith:

Welding on the "Dairyo Maru"

The Dairyo Maru was a steam trawler, 95 ft. by 26 ft. beam and by 12 ft. 6 in. in depth, and calculated to be capable of carrying 297 tons deadweight, provided her upper deck were raised up into a fair line with her raised quarter deck. Her original wood deck planking had to be removed, and the deck had to be plated over. The middle line watertight bulkhead, the bunkers and casings and the engine seat and boiler stools had all to be removed, and the collision bulkhead and the after peak bulkhead had to remain as they were before. Then the vessel had to be fitted with six new oiltight bulkheads, so as to form two cofferdams and five oil compartments, and with an expansion trunk extending the full length of the oil compartment, as shown on the plan attached. All deck houses, casings, funnel, mast, all items of outfit and equipment on the deck, the main machinery and deck ma-



Welds Made on Caisson for Hikoshima No. 2 Dock Showing Bulkhead and Partial Bulkhead.

chinery, the shafting, the piping, all items of engine equipment, which were unnecessary in the vessel as an oil lighter, had also to be removed.

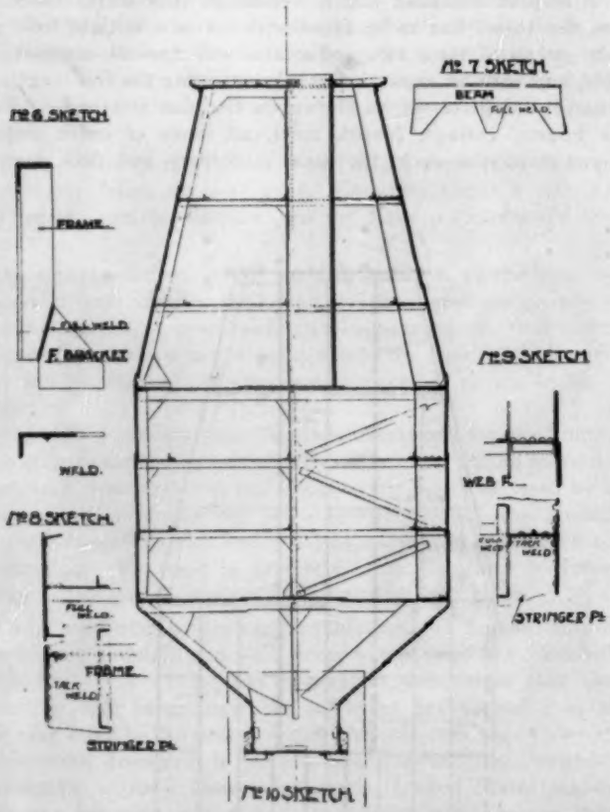
Having rearranged the vessel as an oil lighter, I decided to proceed with electric arc welding as far as possible, wherever the reconstruction of the hull in way of oil compartments and cofferdams permitted, except some parts in the compartments and most parts beyond the compartments which had to be riveted up, because I had only ten experienced welders and five arc lines, and also the contract time prevented my going further with the welding process.

Some of the details of the reconstruction of the hull and application of the electric arc welding may be explained as follows:

*Abstract of Paper Read Before the Japanese Society of Shipbuilders.

Frames.—All frames were left as they were before, and where the deck was raised the beam brackets were made and fitted as shown on sketch No. 1. Each beam bracket was lapped on to the beam angle and tack welded on the slab; placed in position, bolted to the head of the original frame, faired and riveted with two rivets and afterwards tack welded to the shell.

Where a new bulkhead was arranged, the original reverse frame and floor plate were removed, the beam angle was renewed with an angle of same size as the main frame, and extended down to the head of the original frame. The bulkhead plating was lapped on to the frame, as shown on Sketch No. 2.



Welds Made on Caisson for Hikoshima No. 2 Dock. Midship Section.

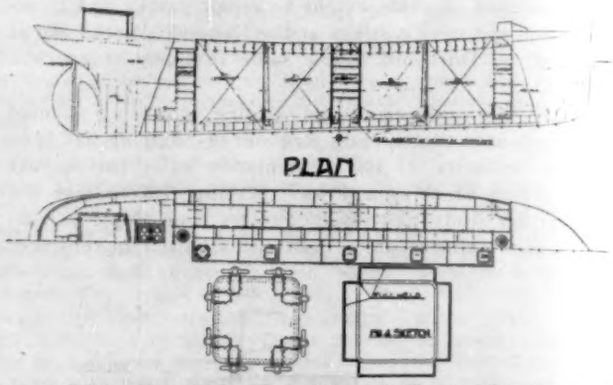
In order to make the ordinary frame oiltight, the heel of the frame angle to the shell, and the lap of the bulkhead plate to the vertical flange of frame bar, were full welded on the same side of the frame and tack welded on the other side.

Keelsons and hold stringers.—These were left as they were before, but were cut in way of the new bulkheads, and compensated with bracket plates. These brackets were tack welded to the shell and bulkheads, but riveted to the keelsons and hold stringers (see profiles).

Upper deck beams.—The original upper deck beams were utilized as much as possible, but where these proved short in consequence of the disposition of the new bulkheads (for instance, the half beams in way of the original hatchways) they were lengthened with the same size of angle and joined into one length by full welding on the slab before they were fitted in place, and the beam bracket was fitted as already described.

Upper deck plating.—The original deck stringer plates were utilized, but the holes for the original waterway angles were filled up by plug welding, as these angles were dispensed with altogether. New deck stringer angles in this case were fitted on the underside of the plate between the bulkheads intercostally, and riveted to the shell and deck stringers. To compensate for the discontinuance of the strength of the bars, short angle lug pieces were fitted on the upper side of the stringer plate and full welded to the shell and deck stringer right round the angle after the deck stringer had been full welded to the shell.

New deck plating was laid in way of the oil compartments and cofferdams and riveted to the beams as usual. All the butts and seams of the deck plating were butted and full welded without any straps, because on such small craft, under 100 ft. in length or so, and, moreover, having only been covered with wood deck planking originally, I did not consider it necessary to increase the longitudinal strength any further, although it might be necessary in the case of a large ship. I also found that it is far easier to make the deck oiltight without lapped seams in way of the bulkheads, and also to keep it dry.



Plan and Elevation of the "Dairyo Maru," Showing Location of All Welded Joints.

Expansion trunk.—For the side plating of the trunk, the original bulwark plates, which had been removed and replaced with the new sheer strake plates where the upper deck was raised, were utilized, after such openings as water spouts, scupper holes, etc., had been closed up with pieces of plate, and full welded right round; and where required, new plates were fitted. The trunk side was connected to the upper deck with a bar, and the heel and toe of the vertical flange of the bar were full welded. The deck flange was riveted to the upper deck, and its toe light full welded as shown on sketch No. 3. The butts of the trunk side were butted and full welded without straps. As to the trunk side stiffeners, flat bars were used and fitted, tack welded to the trunk side and bolted to the upper deck half beams and trunk top beam as shown on sketch No. 3. The spacing of the stiffeners was the same as the spacing of the frames.

The trunk top plating was riveted to the beams and full welded at the seams and butts without laps or straps and the top corners of the trunk were full welded without corner angles.

The manholes or oil hatchways were formed of angle bars fitted on the trunk top and full welded. Anglesmith work on these hatches was very easily done, as shown on sketch No. 4, by simply cutting the deck flange and bending the vertical flange to the shape at the corners and by butt welding at the end of the angle bar. The hinges to the manhole door and the tightening screws were just fitted on to the door and the manhole angle where convenient, and tack welded, without any holes either in the door or the angle or in the hinges, thus dispensing with all drilling, and the trouble of leaks.

Bulkheads.—Six entirely new oiltight bulkheads were fitted in place as arranged on the profile plan. All the longitudinals were cut at the bulkheads and connected to them with brackets.

As the bulkheads were comparatively small in size, the plating was arranged vertically. The bulkhead plates were butted and full welded to the required length on the slab (I took them from stock), and the angle stiffeners were fitted on the

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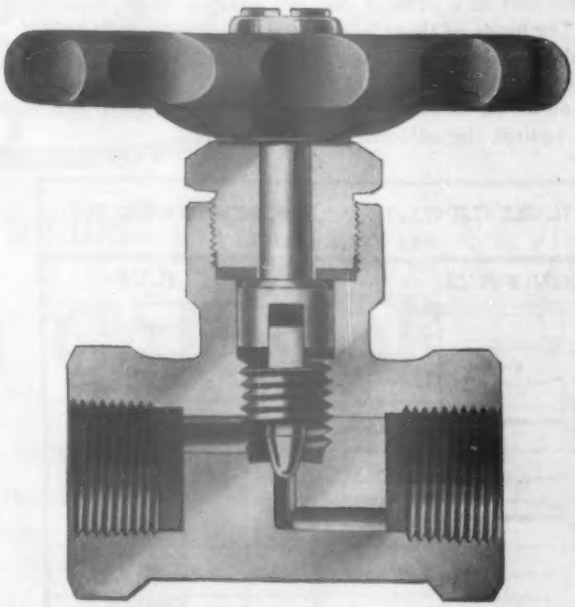

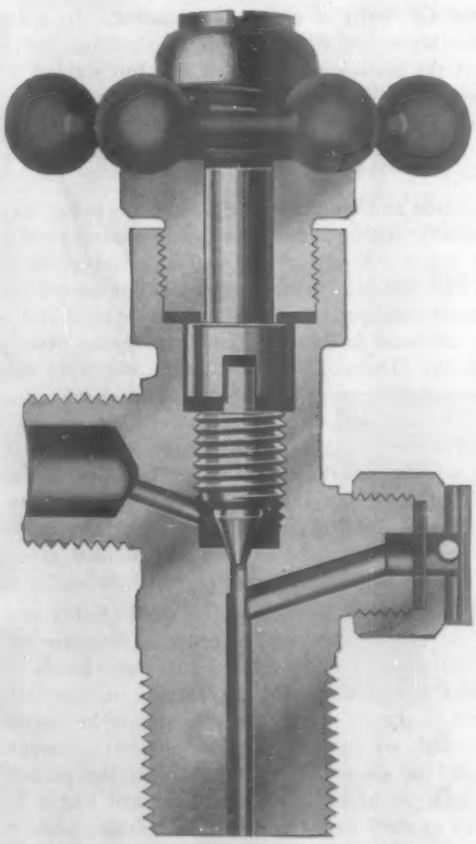

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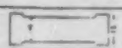
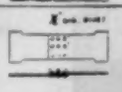
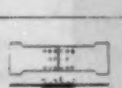
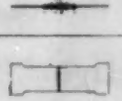
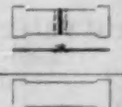
plate, as shown on the section of the bulkhead and tack welded on the slab also. The size of the stiffeners is a little smaller than those required by the Government Rule (in the riveting system), and the spacing arranged a little closer. After these had been done on the slab, the plates were brought to the ship fitted in place, lapped at seams and full welded at one edge of the lap and tack welded at the other.

To secure the bulkhead plates vertically, four service bolts were provided at a suitable distance apart to one side of the seam. The heads of these bolts were temporarily tack welded to the plate, and extended washers fitted over these bolts fastened the plate laps together. The plates were tightly secured to the bulkhead boundary angle by means of wood shores wedged against the adjacent frame.

TENSILE TEST RESULT FOR ELECTRIC WELDING & RIVETED JOINT
MILD STEEL PLATE

SKETCH OF PIECES	TONS PER SQ INS	TONS IN % OF ORIGINAL	ELONGATION FOR 2"	%		REMARK
	31.5	100.00	6¾ 6½ 6¾	23.8		ORIGINAL
	22.6	71.74	⅞ ⅞ ⅞	1.4		CAULKING OPENING 87.5 TON
	21.1	66.98	⅞ ⅞ ⅞	1.9		CAULKING OPENING 64.8 TON
	24.2	76.82	1⅛ 1⅛ 1⅛	5.3		CAULKING OPENING 81 TON
	20.7	65.71	1¼ 1¼ 1¼	4.6		CAULKING OPENING 71.3 TON
	21.7	68.88	1⅜ 1⅜ 1⅜	6.3		CAULKING OPENING 121.1 TON
	21.7	68.88	1⅜ 1⅜ 1⅜	6.3		CAULKING OPENING 97.2 TON
	31.5	100.00	2¼ 2¼ 2¼	8.1		
	31.3	99.36	2⅜ 2⅜ 2⅜	9.5		
	31.5	100.00	2½ 2½ 2½	10.0		
	31.8	100.95	3⅜ 3⅜ 3⅜	13.0		
	31.2	100.00	4⅜ 4⅜ 4⅜	16.4		ORIGINAL
	27.3	87.36	1⅝ 1⅝ 1⅝	5.3		
	28.4	91.02	1¾ 1¾ 1¾	5.6		

Weld Test Chart.

I had some fears as to whether or not vertical welding on the seams could be successfully executed by our workmen, but it was done very well. Overhead welding was also managed very well, but it occupied more time. The watertight testing with a water head of 6 ft. above the trunk top was very successfully carried out; though we found slight leakages at places where overhead welding had been done. They were caulked and stopped at once.

Bulwark and its stays.—New bulwark plates were fitted, lapped to the sheer strake and full welded at seams and butts. As to the bulwark stay, I used a piece of slate and fastened it directly to the deck and to the bulwark by tack welding with no connecting angles.

On a Steel Caisson

On this undertaking the following parts were arc welded: Frame to frame bracket; beam to beam bracket, and to a bracket in way of center stanchion; hold stringer to shell; frames and web frames; deck stringer to shell and frames; seams and butts of upper deck plating; bulkheads and trunks; shell flange of web frame, floor plate to box keel; at bended corner of angle bar worked by anglesmiths, etc.

Frame to frame bracket.—As shown on sketch No. 6, the heel of the frame bar was cut, butted to the frame bracket and full welded on the slab to the shape.

Beam to beam bracket, and a bracket in way of center stanchion. As shown on sketch No. 7, the brackets were made to the shape, butted and full welded in position on the slab, entirely without laps.

Hold stringer to shell, frames and web frames, as shown on sketch No. 8. The stringer plate was burned off by acetylene gas and cut to the shape of the frame bar where frames pass through; fitted in place and tack welded directly to the shell, without any shell angle between the frames, and tack welded to the frames and to the web frames at ends, but riveted to the beams. By this method, the longitudinal strength might be restored to a certain extent by welding the break in the stringer plate to the frames and web frames, and also by adding a small piece of plate to the outside of the face flange of the web frame and full welding to intercostal stringer plates as shown on sketch No. 9. The stringer face angles were riveted to the stringer.

Deck stringers to shell, and web frames.—Deck stringers, except where watertight decks were not required, were fastened and welded as in the case of the hold stringers. Where watertight deck plating extended over, the deck stringers were connected to the shell with an angle bar and riveted, and the butts and seams were full welded.

Seams and butts of upper deck plating.—In order to facilitate the laying of the wood deck planking, the seams and butts of the plating were butted and full welded, but the upper deck boundary angles on the upper side of the deck stringer and longitudinal shell connecting angles underneath the stringer were riveted. (See midship section of the Caisson.)

Bulkheads and trunks.—The bulkhead plating was arranged horizontally, and lapped on the clincher system and full welded on the upper side of the laps and tack welded on the bottom side. The bulkhead boundary angles connected to the bulkhead and to the shell were riveted to the shell and full welded to the bulkhead just in the same manner as described in the case of the "Dairyo Maru." The trunks were plated vertically and their corners full welded without any corner angles. Flat bars were used as the vertical stiffeners spaced about 24 inches apart. On these short angles lugs were tack welded on the slab before they were fitted in place, to secure them to the bulkhead, and then they were fitted on the bulkhead and tack welded. The trunks had no deck angles except those on the upper deck, which were full welded directly to the deck (see W. T. bulkhead and partial bulkhead plan).

Shell flange of web frame.—The shell plating was arranged on the clincher system, and in order to dispense with tapered liners (because if I could have got some hands and time, I thought I would also weld the seams), it was intended that the shell flange of the web frame should be joggled. However, I had no hydraulic press powerful enough for this work, and no channel bars suitable for the purpose, and so the webs were built up to the shape and had a joggled flat bar fitted as shell flange and just an ordinary plate bar as face flange full welded to the web plate.

Floor plate to the box keel.—The floor plates were fastened against the short angle lugs which were tack welded to the keel plates before the keel was laid on the blocks and then tack welded to the keel, as shown on sketch No. 10.

At bent corners of angle bars worked by the blacksmith.—These bars, such as upper deck end corner bars, hatch corner bars, etc., were made in short pieces and bent by the anglesmith by cutting one flange and full welding directly, or adding a small piece of plate as the case of bending may re-

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quire, and then fitting in place. This arrangement greatly simplified the smithwork.

Miscellaneous works.—Compensating doubling plates to maintain the strength, and doubling around manholes, were punched for tack holes only, and after being secured in place these holes were plug welded and full welded right round the doubling without any holes in the plate to which the doublings were fitted. The plates for the floating pipes were bent to the shape and full welded at the butt edges, and then they were placed in position and full welded to the shell and the fore and aft diaphragn plates with no connecting angles at all. Hand rail stanchion sockets, steps, eyeplates, and all similar deck fittings were placed in position as required and tack welded. The fastening bolts for the fender timbers outside of the box keel and around both ends of the caisson were arc welded to the plating with no holes in it. In all cases the widths of welded laps were reduced to the width of single riveted lap joints.

I would call your attention to a table showing tensile and elongation test results of arc welded and riveted joints on mild steel, made by the Nagasaki Shipyard of the Mitsubishi Shipbuilding Co., Ltd., from which you may clearly observe the results. It may be that the alternating bending tests on arc welded joints will show some defects as compared with the original mild steel plate, but I should like to ask you to discover for yourselves if a plate, cold joggled, could stand against the same alternating bending tests any better than an arc welded joint. It may be that foreign matter and defective material can be found in an electrode, and cause porosity of the weld, but it is very difficult to inspect and avoid them, but can you by looking at any castings find out any internal defects and be assured the casting is perfectly sound, without breaking it?

After all, a very important factor is the experience and skill of the arc welder, but this is also true not only in the matter of the electric arc welding, but in every other trade equally.

The principal advantages and disadvantages of the electric arc welding process may be roughly summarized as follows:

Advantages

1. Minimizing the marking labor on material and the saving of time.
2. Minimizing or dispensing with punching or drilling labor, tool damages, and saving of time and tool costs.
3. Minimizing the costs of transportation of materials and saving of time.
4. Minimizing the number of service bolts and washers and the labor of securing; and saving the loss of bolts and washers and also of time.
5. Minimizing the number of rivets, the labor of riveting, the consumption of coal, the damage to riveting tools and rivet heating forges.
6. Minimizing the drilling labor for deck fittings and the saving of time.
7. Minimizing the width of the laps and butt straps of the plating, the numbers of connecting angle bars and the rivet heads, or dispensing with them altogether, and the saving of the materials.
8. Minimizing the caulking labor and time.
9. Minimizing the number of punching machines and drilling machines in the yard, and also the air compressing plant if pneumatic riveting hammers are being used.
10. Minimizing the general labor and oils, etc., in connection therewith.

Disadvantages

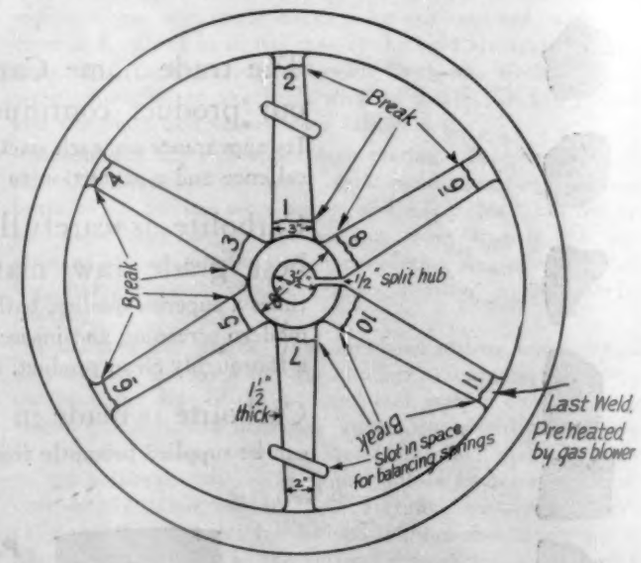
1. The increased length of plate edge planing and beveling, and the labor and time in connection therewith.
2. Increased difficulties in securing the material in place and the time occupied in doing so, especially on double curved plating. (It is expected that these items will be reduced by skillful design and increased experience on the part of the men.)
3. Increased electric installation and power.
4. Increased labor to fair the deformations or buckling of plates caused by the welding process and the time occupied in connection therewith.
5. Difficulties of inspection.
6. Difficulties in obtaining well-experienced welders at present.
7. Slowness of the welding speed as compared with the present speed of riveting, and specially on overheard work.

By studying and investigating these comparisons, it will be found that, after all, a saving may be effected on labor, time and costs.

PUTTING A FLYWHEEL BACK IN SERVICE

By A. J. Derenzo

Here is a diagram of a badly broken flywheel which we recently welded in the shop of the Chicago Welded Products Co. The only preheating done on this job was done on the very last weld where one of the spokes was broken off at the



outer flange. This little bit of heating was done by a gas blower. The numbers on the sketch indicate the order in which the welds were made. Each weld was allowed to cool before starting the next one. When the job was finished and cooled every spoke was given some hard blows with a heavy hammer to make sure that no strains had been left. Then the wheel was rebalanced and put in service.

A. S. M. E. WILL HOLD SYMPOSIUM ON WELDING

The Spring meeting of the American Society of Mechanical Engineers will be held this year at Atlanta, Ga., May 8-11. Excursions to other southern cities will be included in the program. On Thursday, May 11, one of the three simultaneous sessions will be a Symposium on Welding, with the following program:

"The Strength of Electrically Welded Pressure Containers," by R. J. Roark.

"Some Principles of the Construction of Unfired Pressure Vessels," by S. W. Miller.

"Steel for Forge Welding," by F. N. Speller.

"Tests on Welded Cylinders," by E. A. Fessender and E. J. Bradford.

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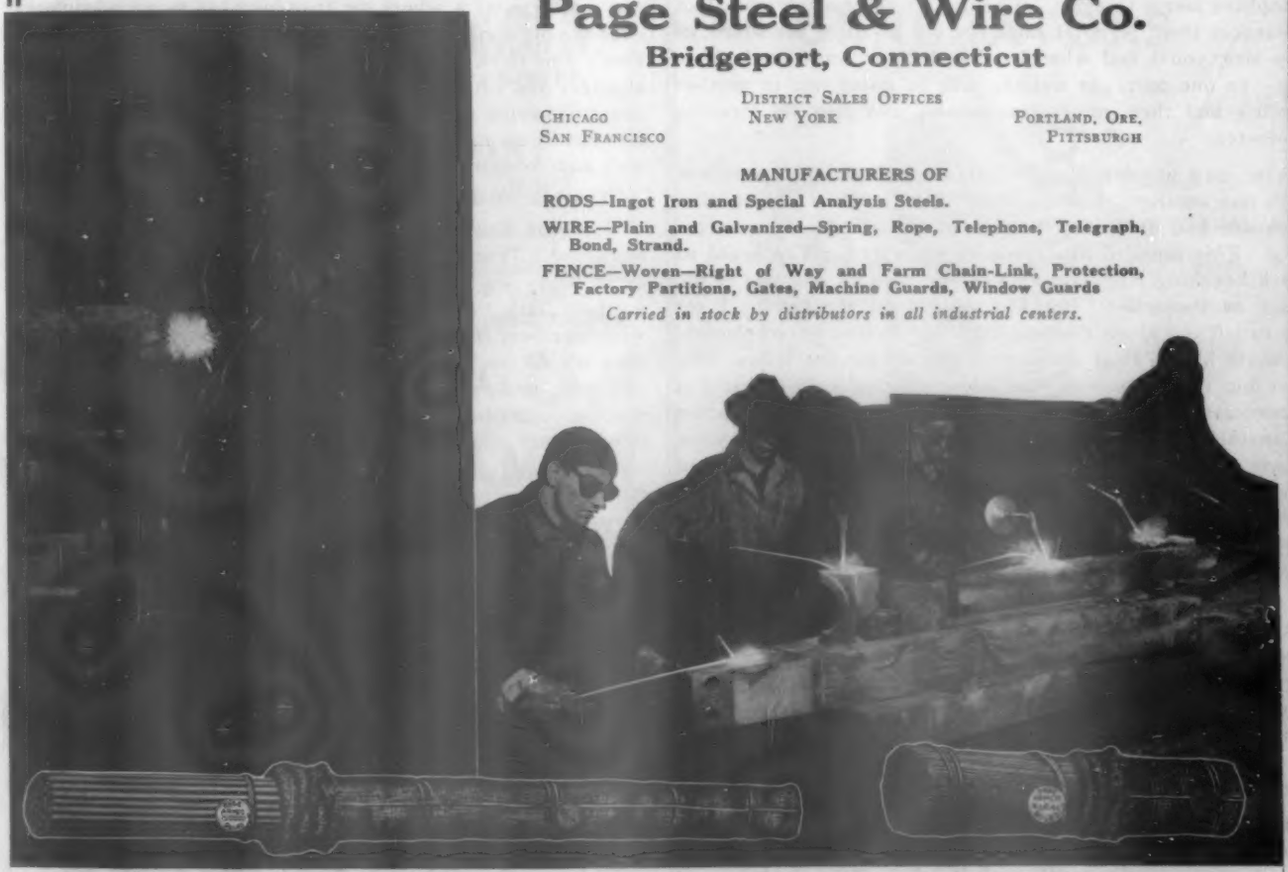

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WELDING RODS and ELECTRODES

WELDED BICYCLES MAKE A HIT

Production Job Started as a "Fill-in" and Develops Into a Steady and Profitable Business

Spokane, Sunday Morn.

Dear Ed:

I left Seattle on Friday but I dropped off at a little town called Ellensburg, just this side of the Cascade Mountains. It looked to me as if it might be located right on the edge of that famous Yakima Valley so you'll have a general idea where it is. Why did I stop there? Simply because I found out on the Coast that a firm was turning out welded bikes for children and it sounded as if it might be interesting.

These westerners sure have some original ideas. Methinks they must have a little more time evenings to get down and dope out new ideas than the crowd in the larger eastern towns. It was noticeable all along the Coast that even the commercial welding shops were far better equipped to take care of their trade than many of the other shops I've visited. The minute a fellow gets over the mountains a different atmosphere seems to exist. Whether it's the marine work that influences them or not I can't say but in all of the shops, of any size, you'll find what is termed "four way" methods in use. In one part, gas welding will be going on; in another electric and then comes the thermit and also the brazing processes.

You may wonder if the different methods don't interfere with one another. I asked about that and they told me that each one had its field and there was practically no overlapping. This sounded like music to my ears for I've heard so much knocking from converts or salesmen on one side of the fence or the other. But I'm getting off the track. I set out to tell you about that welded bike. Before I start though, I should like to clear up matters so that the fine fellow who gave me this dope won't be under the impression that I'm "broadcasting" this information to encourage duplication or anything like it. That is the thing furthermost from what I have in mind. The fact of the matter is that methinks they have this particular article pretty well protected, but to make myself perfectly clear I'm going to get it out of my system.

Ed, your shop is characteristic of a large number of shops doing jobs welding, in this respect: You can't regulate your trade and sometimes you have work galore and then bang! a few slack days. You must be prepared to take care of your trade at all times and give prompt service because in the welding game most of the jobs are emergency, or rush jobs, and if you can't give the right service they go to the man who can. But if you're going to have enough help on hand to take care of the "peak" loads, what's going to make it pay you to keep this help during the slack periods?

To me the logical answer seems to be: Figure out some standard manufacturing proposition that the men can be placed on at any time. What shall it be? Why that's a matter that may take some little time to dope out, but if given proper consideration it can be done. I'm taking this bike for an example. This firm, after giving the matter much thought, figured that there was a field for a boy's and girl's bicycle that could be built so sturdy and strong as to make it practically indestructible. At first it served only as a "fill-in" job but very soon it grew so fast that it was the main thing and the shop graduated from a job shop to a manufacturing establishment having a good steady business. If, in telling about the making of this particular article you may gain an inspiration that is valuable, the effort will be well worth while.

At the plant of the Smith Manufacturing Company I was turned over to the superintendent who showed me through the shop and took all kinds of pains to explain everything in detail. After we had looked around a while I asked him how they happened to hit upon the idea of making welded bikes.

"We just got an idea that there might be a demand for a low priced outfit like this, so we tried it out on the local kids and then all doubt about its not being a winner left us," he answered. "It took like wild fire."

"The lines are certainly good," I said, "no wonder it appealed. I've been trying to figure out what it put me in mind of, but now I know, it has sort of an armoured look about it. Guess it must be those disc wheels that gives it that appearance."

"We think that's a pretty foxey idea," my guide said, "You see that type of a wheel for that bike has many advantages over the old spoke type. In the first place it's better looking. Don't you think so?" I nodded. "In the second place, it's stronger and can't warp; thirdly, it's safer for children on account of having no spokes to catch the fingers or clothing and last but by no means least, its cost is so low that really there isn't any comparison with the ordinary type of wheels."

"That's a solid rubber tire you're using, isn't it?" I asked.

"It's just like a baby buggy tire only much larger," he answered. "You see in reality it's simply a tubing with an extra heavy wall; by slipping in a wire through the center, we hold back the ends of the tubing; weld the ends of the wire together; let the ends of the tubing come together again; then it's all ready to put on the wheel. A tire of this kind, you must understand, isn't to be confused with a pneumatic, when it comes to absorbing bumps, but to off-set that feature, it is punture proof, costs less and has the same appearance."

"About the only thing you don't make is the saddle, isn't it?" I asked.

"We buy the saddle, the grips for the handle bars, as well as the sprockets and chain, none of which cost us very much."

I walked over to examine one of the frames a little closer. "The whole thing is made of very small channel iron, isn't it? with the exception of the tubing, the saddle and front fork fit in. Not a bolt or a rivet used any place that I can see. You weld everything, don't you?"

"That's the idea," he replied, "we want it just as husky as it's possible to make it. We figure you can't make a thing too strong for children's use. Everything is put together to stay and thereby we have a fool proof feature. Now, if you care to see how these frames are made I'll take you out in the next shop."

That was the opportunity I was waiting for, so we went. "Over here," he continued, "is where we cut our bars to size. Being such light stock it goes fast and one man can take care of all the cutting as you see. Now over here," and he lead me to another part, "you can see how we do our bending. There is one bend in each of our long bars and it's quite necessary that these be fairly sharp and don't buckle. With this light channel iron we found it rather difficult until we made up these jigs. First we clamp our stock in thusly, then turn our welding flame on at this point where we want our bend; when it's red hot we give her a flip and it's all over for that one and we're ready for the next. From here these parts go

(Continued on page 56)

—a known fact

in making cast iron welding rod the foundry can do one of two things.

1. Use scrap material and make a nice profit at any price, or

2. Use *S. A. virgin pig iron and by-product coke only, with careful laboratory control to insure freedom from porosity, high silicon and low sulphur content and practically no oxide on finished weld surface.

Just ask for free samples of Fre-Flo rod and you'll make a ready decision as to which classification it comes under.

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KEROSENE FLAME

is the quickest, most practical and economical way

IF YOU USE A NON-CARBONIZING BURNER

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Spreads a sheet of flame under the casting.
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SUN-LITE

WELDING IN THE STEEL PLANT

(Continued from page 29)

instance, we can make a deposit that will average .90 carbon. Of course, there are several little stunts and kinks in this that are practiced, such as using glutrin to mix the manganese and carbon with, which under heat is very liquid and under normal atmospheric temperature is stiff and hard. In that way a coating of any thickness can be placed around the electrode and as the arc melts the electrode and deposits it in the crater, the carbon will be melted in that crater and added to it, or partially dissolved by the steel.

Now, as I mentioned, this method of adding carbon is very irregular and hard to control, so to my mind it is not a perfect way of adding carbon by any means. I am doing a little work along that line now. I have not completed it far enough to go into detail, but I expect in a short time to be able to give out more information on that subject.

As far as special rods are concerned on a.c. work, it has always been emphasized to me by a.c. men that the rod should be coated. As far as my experience goes, I have found that a rod coated with any flux or any material which volatilizes at the temperature of the electric arc will manipulate with considerable ease, over the bare rod, because of the fact that the arc can be drawn out a greater length without breaking. With the bare rod on low voltage, the arc can only be drawn out to approximately one quarter inch, and where it has a substance that can volatilize under the heat of the arc it will be drawn out to an inch.

We have found that the wearing quality of an electric repair of that kind, made with a high carbon electrode, and even an electrode coated with carbon, can be made to wear just as long as the thermit weld with the cost greatly under that of the thermit weld. But in making additions and in making built up surfaces of this kind, with the high temperature of the arc, you always get contractions in building up metal because each little drop that is deposited comes down from the high temperature of the electric arc, or a great deal above the temperature of melting steel, to solidification and to black heat, and during that time there is a great contraction in the weld, and the strains if not permitted to go out, are not released but built up.

When you build up any amount with metallic arc, your deposited metal is full of strains, full of little internal strains running in various directions. These, under vibration, will release and crack. If one little crack like that starts, the hammering and vibration set up in the reversing and operating of a mill will keep the crack lengthening and soon you have a broken part. We experimented on pinions to get exact information and found the hazard of locked up strains was too great to warrant using metallic arc on that class of work.

I have always maintained, however, that the life of an electric weld, where the hammering will not be so severe that it will break it, that the wearing qualities are just as good as the thermit weld, and the cost of making it is so far under the cost of thermit weld that the latter is not considered at all.

I refer to Sheet Mill spindles, coupling boxes and shafting where it is never brought up to the maximum strain.

The angle and spacing is a very important point. I possibly should have gone into that, but in making my outline I tried to cut it down as short as I could. When I started this paper, I didn't know I was supposed to have the whole evening or I guess I would have written a book. The angle, though, I want to say, depends a great deal on the job. Any angle that permits you to get down and see that the crater of the electric arc cuts clear through, is an angle that is permissible and the thing to do on a production job is to get that angle to the smallest amount that you possibly can and be safe, but be safe first. Increasing an angle just enlarges the volume of deposited metal to be put in and, of course, makes a greater body there to be filled with internal strains, and, furthermore increases the time of making the weld. Thicknesses, such as an eighth inch and three-sixteenths, that can be welded clear through, are all right, but thicknesses from three-sixteenths up to half an inch should be beveled so that the surface covered by the crater is not too great and so that added metal will not fall upon unmolten surface.

Analysis of rods show that a pure iron rod, having a tensile strength under hard drawing of sixty-five thousand pounds per square inch, will through the electric arc come down or be annealed so that the tensile strength of the deposit is only about forty-five to fifty thousand pounds per square inch. Now you can put a rod of that kind on a steel sheet having a tensile strength of sixty thousand pounds per square inch or one hundred and twenty thousand pounds per square inch, and of course you get the break in the weld because a perfect weld will be the tensile strength of the soft iron rod.

Now, if it were possible to weld higher carbon, which of course increases the tensile strength of the plate as you all know—if it were possible to get the absolute maximum strength of the arc welding in those higher carbons, you could, of course, get above the range of sixty thousand pounds per square inch with electric welds. But when you go higher than .20 carbon you get a weld that is crystalline in formation, and brittle. It is stiff and strong but it will not stand the greatest abuse of hammering.

In answer to the coated rod question, I may state that there is an electric welding rod put out coated with asbestos and wound with aluminum. That rod is considered the best by some men for overhead welds. They maintain that the weld is annealed better by having that flux float on the surface, and that the arc or metal as it passes from the electrode to the crater is protected by the gases that are formed under high temperature of the arc, which is a very good point and I believe that they are right, as long as they don't get something there that bothers the operator. If he can't see the weld then he can't see the thing that he is put there to do. If there is too much coating it mixes in with the weld, which is worse and more bothersome than no coating.

There is also another coated rod on the market that is claimed to be helpful for d.c. welding. It is coated with a combination of calcium hydroxide and water glass. It protects the arc and does a few things that are of value on that line.

Mr. Henderson wanted more information on the nickel steel; due to the fact that nickel burns out under the electric arc, and that the weldability of nickel steel is poor, results vary and in no case shows anything favorable toward electric welding nickel steel, however, for acetylene welding nickel steel gives very good results.

Mr. Carl Davis made a remark that I was glad to hear. He spoke about the operator. The operator, of course, cannot be expected to be a jack-of-all-trades. To be an expert electric arc operator, he must have practice continually. I know myself that I can't go out in the plant and pick up an electrode and do what I want to do as I can with practice. You can readily see that if a man is used to feeding a rod down steady, to weld overhead would be a reverse operation. For that reason many an electric operator will stop and practically give up when he has to do a job overhead. After he gets experience and is practiced up, he can weld overhead as well as any other way.

Further, on the man's ability to make a perfect weld and to not do it just for the surface or appearance of the weld, a man's character can readily be judged by the way he goes about making the weld. If he goes into it to make a good looking surface and nothing else, that is all there is of the

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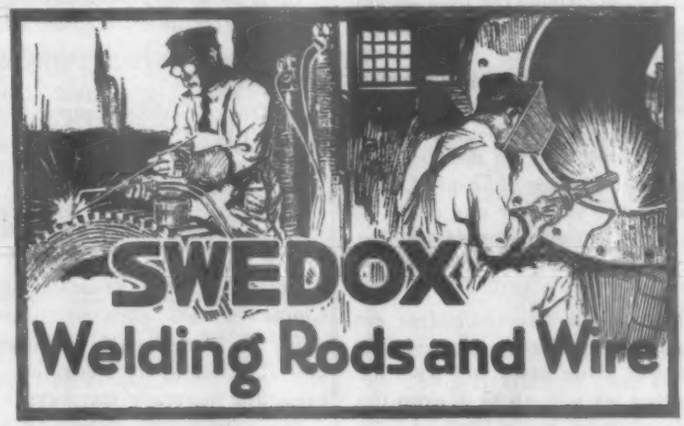

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"WE COULD NOT KEEP HOUSE without HAUCK PREHEATERS"

writes W. A. McElvain, proprietor of the McElvain Welding Shop, Enterprise, Kan.

In submitting photograph of a big fly wheel he had repaired, he says —

"This wheel is about 2½ tons. Four spokes broken at hub. Hauck torches were used to expand the 12x5" rim, 6" diameter. Job turned out O. K. and has been in service more than six months. This is only one of the many places where we use Hauck torches."

Mr. McElvain uses the No. 7 and 8 Hauck double burner preheater, described in bulletin No. 127; copy mailed upon request.

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122 Tenth St. Brooklyn, N. Y.

man. But if he digs through and builds up a good solid foundation, making sure that he has a perfect cross-section, that is a man you can bank on, and that is the only kind of a man who will make good welding.

The proper maintenance of a welding department is a very essential thing. I waged a war on that several years ago and finally came through with it. As this gentleman said, we had one man doing acetylene, another doing electric and another doing thermit welding, and each claimed the jobs should be done this way and that, when difficult jobs came, and on many occasions the right process was not used. I went after the thing as scientifically as I could and arranged those men so that they would cooperate, and then finally put them in one Department. They are now working under one head and have a very efficient Department. It is only through the cooperation of those three, or any other methods that are applied, that you can get the highest efficiency out of either one of them.

Mr. Fishel brought out the classification of welds and the fact that electric is so much cheaper than the acetylene or thermit, which is a point well taken.

Mr. Davis of Lincoln Electric gave a very interesting remark in line with new developments on carbon arc welding. It only emphasizes the fact that in many cases when we see a thing that is better than another we will go to it, drop the first altogether before having developed it to the limit. I have not had a very great use for the carbon arc lately, except as I have mentioned for heavy work, but there is no reason in my mind why the carbon arc cannot be controlled so that it will unite two bodies in a homogenous mass, and if it can make the speed that he claims for it, it will make a big addition to manufacturing.

ELECTRIC WELDING RESEARCH COUNCIL

Recently there was organized in Chicago, the Electric Welding Research Council, for the purpose of collecting and compiling such data as is now available as regards the design and use of Electric Arc Welding equipments, Electric Arc Welding materials, and materials to be electric arc welded, the mechanical design of parts to be electric arc welded, the application of the weld, successful practices, etc., and for continuing research and development work such as will prove of benefit and aid in directing the extension of the electric arc welding process into broader fields and bettering the practice all possible in the fields were now employed.

In addition to accummulating all of the data that is available at the present time, it is the intention of the Council to carry on development and research work, including the commercial application of the art to high pressure vessels and structural steel welding.

This organization has been developed to work in conjunction with the American Welding Society and to furnish them with commercial data and information and in fact to lend their assistance to the American Welding Society and the American Bureau of Welding in every possible manner. This organization might be said to function in a manner somewhat similar to the Acetylene Association, which functions in addition to other lines of endeavor for the improvement and betterment of the gas welding and cutting process.

This organization is composed of the following members:

Professor H. F. Moore, professor of Research of Engineering Materials, University of Illinois.

O. T. Nelson, president of the General Boilers Co., Waukegan, Ill.

R. E. Kincaid, Western Electric Co., Chicago, Ill.

H. R. Pennington, supervisor of welding, R. I. Lines, Chicago.

J. H. Pethrick, Jr., Maryland Casualty Co.

Geo. Austin, general boiler inspector, A. T. & S. F. R. R., Chicago.

R. A. Fisk, mechanical engineer, General Boilers Co., Waukegan, Ill.

P. O. Noble, General Electric Co., Schenectady, New York

Wm. Williams, Standard Oil Co., Chicago, Ill.

A. C. King, consulting engineer, Chicago, Ill.

E. Wanamaker, electrical engineer, R. I. Lines, Chicago, Ill.

H. C. Freeman, Freeman Mfg. Co., Racine, Wis.

O. H. Eschholz, Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.

A. Oliver, welding supervisor, General Boilers Co., Waukegan, Ill.

J. P. Collins, U. S. Bureau of Inspection and Locomotive Repair.

C. O. Myers, secretary, National Board of Boiler & Pressure Vessel Inspection.

Gerald Gearon, assistant chief boiler inspector, City of Chicago.

Mr. T. D. Sedgwick, engineer of test, R. I. Lines, Chicago, and E. E. Chapman, engineer of test, Santa Fe R. R., Chicago, are honorary members.

The following committees have been appointed and are already functioning:

The Welding Equipment Committee—A. C. King, chairman, O. H. Eschholz, R. E. Kincaid, P. O. Noble, H. R. Pennington.

Welding Materials and Material To Be Welded Committee—R. A. Fisk, chairman, O. H. Eschholz, P. O. Noble, Prof. Moore, A. Oliver, W. Williams, H. R. Pennington, J. H. Pethrick, Jr., Geo. Austin, H. C. Freeman.

Committee on Mechanical Design and Method of Application—R. E. Kincaid, chairman, Gerald Gearon, A. Oliver, E. Wanamaker, C. O. Myers, J. H. Pethrick, Jr.

Mr. E. Wanamaker is acting chairman of the Council.

It is the intention of this Council to gather together all of the data now available on the Electric Arc Welding Process; such as will guide the prospective user, and user of the process; also the ultimate consumer of the electric welded product in the proper selection of equipment, welding materials, material to be welded, designs, method of application, etc., as will result in safe and economic use of this new art. This information will be furnished to anybody desiring same, through the medium of the press and the American Welding Society and the American Bureau of Welding.

It is felt that this comparatively small Council with its lack of top-heaviness will have the ability to function rapidly and by calling upon those engaged in the electric arc welding process, the Council will not lack for the available assistance which it requires.

It would seem that it lies within the province of this Council to do much good for the electric welding art. The Council requests that anybody having any information regarding safe and economic welding practices will forward same to the Council, care of E. Wanamaker, electrical engineer, Rock Island Lines, LaSalle St. Station, Chicago.

C. E. Skinner, scientist of international reputation and manager of the Research Department of the Westinghouse Electric & Manufacturing Co., has been appointed assistant director of engineering in that company. His duties as assistant director will cover research, standards and other work along these lines. He will be located in the main engineering offices of the Westinghouse Electric Co. at East Pittsburgh, Pa.

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Conforming to Spec. E1B and G1A of The American Welding Society

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Absolutely uniform in quality

Roebling Wire Electrodes are supplied in the following standard sizes: ¼-in.; 5/32-in.; 3/32-in.; ⅛-in.; 3/16-in.; 7/32-in.; 1/32-in., having a standard length of 14-in., in bundles 50 lbs. each, and are always available for quick shipment. Sizes other than the above and as large in diameter as ½-in., having any length required, either straightened or in coils can be furnished on order. Roebling Electrodes give maximum penetration and maximum strength of welds.

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99.75% Pure Iron

Roebling Wire Gas Welding Sticks are copper coated to distinguish them easily from Roebling Electrodes. They are supplied in standard sizes: 3/16-in.; 5/32-in.; ¼-in.; 7/32-in.; 5/16-in.; 3/32-in.; 3/32-in.; 7/32-in.; and in standard lengths of 36 in. in bundles weighing 50 lbs. each, well protected by weatherproof paper or burlap. Sizes other than the above either straightened or in coils can be furnished on order.

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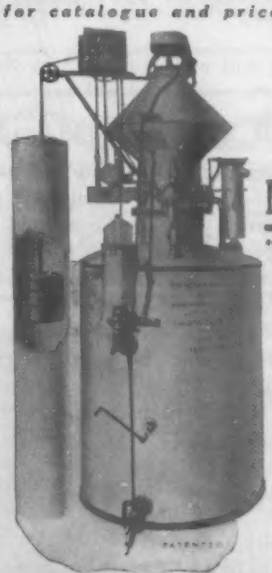

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TORCHWELD patented construction provides many advantages, invaluable to the welding and cutting of metals.

Equal Gas Pressures for Welding, and lower pressures than usual for cutting.

Equal Consumption of Oxygen and Acetylene for welding.

Freedom from flash-backs—regardless of the size of the welding or cutting job.

Positive safety, whereby any attempted flame propagation into the welding or cutting torch is expelled.

Consider also that TORCHWELD welding torches are machined from solid bar brass stock, and that principal parts of the cutting torches are similarly made; all permanent joints are brazed. Heavy duty welding tips are machined from solid bar copper stock, and are sufficiently heavy to make them sturdy, long wearing, and free from seating troubles. TORCHWELD torches are as well balanced as the beam on a scale; they do not tire the operator.

A comparison of qualities and prices will reveal values you will eventually require and demand in torches, regulators, and general welding and cutting equipment.

Buy Torchweld Now!

Torchweld Equipment Company

Fulton and Carpenter Sts., Chicago, Ill.

WELDER AVERTS SMELTER SHUT-DOWN

A job that is typical of the work being done by oxy-acetylene welders and cutters at mines and smelters is illustrated in the accompanying photographs, which show a 300 lb. hydraulic car axle press before and after being repaired.

One photograph clearly indicates the seriousness of the fracture, showing the broken press in two pieces, and the other depicts the press after it was reclaimed by the welder. The latter view might easily be mistaken for a reproduction

A Car Axle Press Before Welding.

of an entirely new press, so well executed is the outer finish of the weld, and that its excellence is more than "skin deep" is attested by the satisfactory service the press is now giving under heavy working pressures.

The press shown is the property of a large refining company in Utah. It is a small part of the company's great plant, but it was found to be very necessary to continued

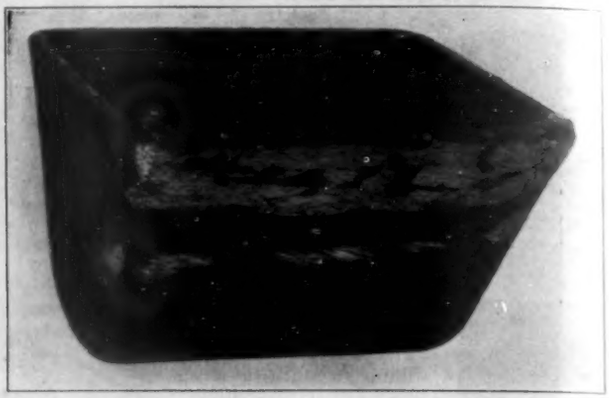
The Weld That Averted a Shut-Down.

operation the moment it got out of "kilter," distinctly emphasizing its importance as a necessary unit in the machinery of production. There was occasion for congratulation, therefore, that the company maintained an ox-acetylene department and had a welder capable of handling the repair without unnecessary delay. The weld measured from 3½" to 6" in depth and was about 6' 3" in length. The job was executed with one torch and required about 200 lbs. of filling material.

POSSIBILITIES OF MANGANESE WELDING

In the past the difficulty of making a thin manganese steel castings has been a stumbling block in the way of the production of small and moderate sized conveyor buckets and conveyor flights, so that nearly all of this class and range of conveyor equipment has been made of either pressed steel or malleable iron, so as to secure a light operating weight. Recently, however, experiments have been made in depositing manganese steel with the electric arc, to form bucket lips and digger teeth, and the unqualified success of the process gives promise that any style of bucket made of steel plate, malleable iron, or steel casting, can be built up at a very low cost and give a very long life to the parts subject to abrasive wear.

One good example of this application of manganese steel welding is shown in the accompanying illustration. This particular bucket is malleable iron. The manganese steel welding material stuck to the malleable iron, making a perfect weld. "Equally good results," writes Mr. L. W. Jones,



Welded Conveyor Bucket.

president of the Manganese Steel Forge Co., "can be obtained on cast or forged managanese steel, steel castings, both carbon and alloy steels; also plate and bar materials.

"With manganese steel welding rods, containing high manganese and high carbon, a cutting lip or cutting tooth that is heavy enough to withstand the welding and give a true manganese steel wearing surface can be built up on a conveyor or digging bucket, and the wearing surfaces thus obtained will have the greatest abrasive resistance of any steel made."

The Will County Welding Company, a subsidiary of the Powers-Thompson Construction Company, has recently been incorporated with $10,000 capital stock. The subsidiary was formed primarily to do the welding of the parent concern, but if it works satisfactorily, will be used as a commercial welding plant.

A new rolling mill will be erected by the Anaconda Copper Mining Co. on the site of the old casting shop at Torrington Conn. This plant was formerly owned by the American Brass Company, makers of Tobin Bronze rod, which concern is now the property of the former company.

The plant of the Standard Manufacturing Company, manufacturers of Superior Brazing Compound, was completely destroyed in the recent Canal Street fire; Chicago. The concern is now located at 947 West 20th Street, Chicago, and are fully equipped to do regular business.

The Brown Instrument Company, Philadelphia, Pa., makers of pyrometers, thermometers, tachometers, etc., have recently added to their property. With the new addition, the concern will be greatly facilitated in handling the business of their customers.

A one-story service station will be added to the Pittsfield Welding Company, Pittsfield, Mass., at their 23 Taylor Street property. The new building will cost $13,000. Emack & Hicks are the proprietors.

The plant of the Central Machine & Welding Co., 38 Bromstone Lane, Montreal, Canada, is increasing the size of its plant to make room for a larger volume of business.

The Annual Convention of the Master Boiler Makers will be held at the Hotel Sherman, Chicago, beginning May 23rd and ending May 26th, 1922.

An Executive Board meeting and luncheon will be held by the Compressed Gas Manufacturers' Association, on May 18th, 1922, in New York City.

Classified Ads

Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address.

For Sale—A slightly used 50 Lb., 50 Cu. Ft., acetylene generator, brand new welding and cutting torches. Apply National Steel Construction Co., Bellwood, Pa.

For Sale—Good opportunity if promptly taken advantage of. Welding shop and full line of hand tools plus machinery in a wide awake community. No other shops within a radius of 50 miles. Owner going to the coast. Write Post Office Box 1287, Alliance, Nebraska.

Help Wanted—All around job shop acetylene welder wanted. A steady job for the fellow who can produce. Address 33, care *The Welding Engineer*.

Wanted—A real oxy-acetylene salesman who can demonstrate. Practical operating experience of value, though not required. Address Carbic Manufacturing Co., 565 W. Washington Street, Chicago.

Aluminum Solder—That will stand the test. No flux required. Send 50c for sample and literature. Do not send personal checks. Formula, $5.00. Address John M. Brackman, 727 S. Oakley Blvd., Chicago.

For Sale—Welding shop established and well equipped, at El Paso, Texas. Reasonable rent; $13,200 will take it, $500 cash and the balance on time. Address Wm. J. Chesak, 1319 E. Missouri Street, El Paso, Texas.

For Sale—Prest-O-Lites covered by service agreements. Transfer of ownership will be made on the records of the Prest-O-Lite Company, Inc., and service will be given from their nearest plant. Address 32, care *The Welding Engineer*. 46-3-6

Lincoln Arc Welders—Complete motor generator units, slightly used, in excellent condition, mounted on wheel truck. Capacity of generator, 150-200 amp. Motor 5 H. P., 440 volts, 3 phase A. C. Price, $700. Metalweld Service Corporation, 1435-37 N. 31st Street, Philadelphia, Pa. 2T-3-4

For Sale—Two 150-ampere, Lincoln Portable Electric Welding outfits. These machines are in as good condition as they were when they were new. Apply to Standard Electric Machinery Co., 7 and 9 East Hill Street, Baltimore, Md.

Dyar Shop Record Cards—

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ESTIMATING SHEET METAL WORK, by Adolph Hauck and Wm. Newbecker—This book tells how to figure the proper sizes of articles made of sheet metal, how to take off the material required from the plans of any sheet metal job and how to buy material and cut it to advantage for different work. Methods are given for figuring the actual overhead expense for any department according to the kind of work handled. It explains the special risks to be considered on making bids on sheet metal work. It gives the procedure for measuring and computing as well as estimating various important sheet metal jobs. The volume is well illustrated and well indexed.—Published by the U. P. C. Company, New York City.

MODERN METHODS OF WELDING, by J. H. Davies—A well arranged volume which presents a clear, understandable description of the principles involved in gas welding, thermit welding, arc welding and resistance welding together with considerable discussion of the materials and apparatus required in the various processes. Chapters on the manufacture of oxygen, hydrogen, carbide and acetylene, the manufacture of oxygen cylinders and the construction and operation of acetylene genertaors are included. Separate chapters are devoted to oxygen regulators and to the regulation of the use of acetylene generators. Such subjects as cutting iron and steel, preparation of work for welding and the function of safety valves and the matallurgy of weldable metals are treated at length.—Published by the D. Van Nostrand Company of New York City.—Price $6.00.

ELECTRO-METALLURGY OF STEEL, by C. C. Gow—Although evidently written for the benefit of the student of metallurgy and the particular steel maker, this book will give the welder who wants to know more about the metals he is handling a lot of useful information on the characteristics of steel. Such subjects as liquid steel refining, electro metallurgical methods of melting and refining cold charges, liquid steel refining, ingot casting and methods of analysis. It tells the reader a good many things about steel that are worth knowing. In this book, the electro-thermic processes of steel making have been studied more, especially in their relation to arc furnaces from which almost the entire output of electric steel is now being made. Little space has been devoted to the construction and operation of induction furnaces although sufficient has been written to indicate their electrical, constructional and metallurgical features and the principles involved.—Published by D. Van Norstrand Co., New York.

ALUMINUM AND ITS ALLOYS, by C. Grard. Translated by C. M. Phillips and H. W. L. Phillips—Aluminum is treated from the point of view of production and properties. The properties of aluminum are divided into three classes, i. e. physical, chemical and mechanical. Under the subject of alloys is included light alloys for casting, light alloys of great strength and heavy alloys of great strength. Important statistics such as tensile strength and elastic limit are expressed in both the English measure and metric. The problem of welding aluminum is not discussed but one chapter is devoted to soldering this metal. In the treatment of alloys, considerable space is devoted to the discussion of duraluminum.—Published by the D. Van Norstrand Company of New York City.

WELDED BICYCLES MAKE A HIT

(Continued from page 48)

to the welding department where the assembling is done. The door is right here, we might just as well step out and see them welded too. This first fellow is just setting up a frame so we'll watch him. See! That jig has a place for every part; they just slip right in and then they're welded. Wherever a joint is to be made it's welded. There is no chance of the parts springing one way or another because they are all held firmly in position as you can see. After the welders finish their part, the frames have a few holes drilled in them and then they are painted before being completely assembled. Notice the way this lad over here is welding up these forks. The same procedure is used as with the frames. This "trussing" feature makes the form much stronger and is patterned after the motorcycle style. This next welder is working on handle bars. Instead of using tubing for this, as is customary, we simply bend them out of rod stock and here they are welded to the shank of the fork."

There seemed to be nothing out of the ordinary in the assembly of the other parts and the testing so we just gave them a hurried glance. On our way back to the office, his highness, you couldn't help but see that I was impressed, burst out enthusiastically, "Yes, sir! When they're all dressed up in that red paint it sure catches the eye of the kiddies and it appeals to the parents too, because of its low cost to start with and the fact that the first cost is the last."

So here you are, Ed, the story of the welded bikes is yours. It's surely surprising to see how some of these products are being changed around to the use of gas welding, isn't it? It's just getting the original notion and putting it into effect, apparently. Well, Butte will be my next stop and I'm expecting mail from you there. Hope you won't disappoint me.

So long for the present. Shep.

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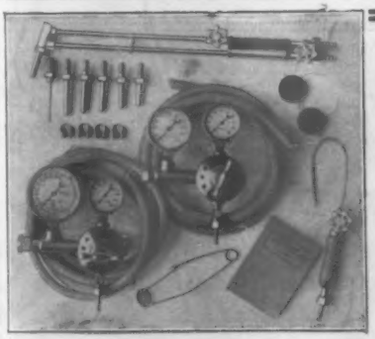

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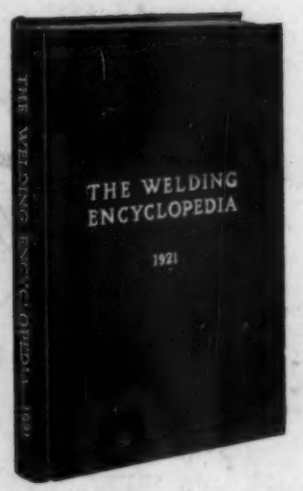

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